DISCOVERY

A MONTHLY POPULAR JOURNAL OF KNOWLEDGE

Edited by Bernard Lintern

Volume XIV

JANUARY TO DECEMBER

1933

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Bouverie House, Fleet Street, London, E.C.4

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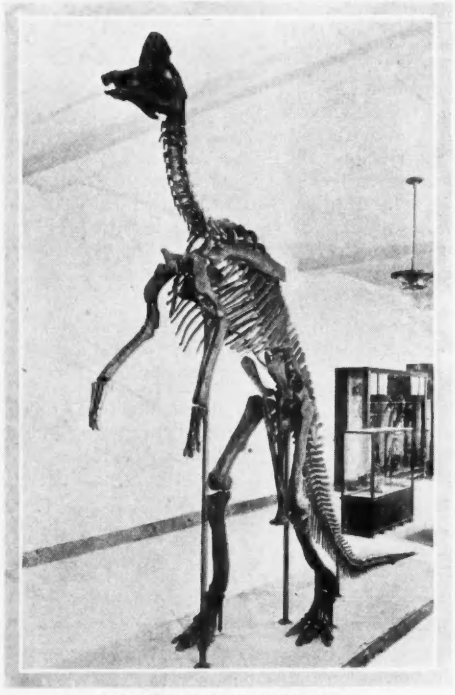

THE DUCK-BILLED DINOSAUR.

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DISCOVERY

A Monthly Popular Journal of Knowledge

Vol. XIV. No. 157. JANUARY, 1933. PRICE 1s. NET

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Edited by Bernard Lintern.

Publishers: Benn Brothers, Ltd. All communications respecting editorial matters to be addressed to the Editor; all questions of advertisements and subscriptions to the Manager.

Offices: Bouverie House, Fleet Street, London, E.C.4. (Closed on Saturday.)

Telephone City 0244. Telegrams: Benbrolish, Fleet, London.

Annual Subscriptions 12*s.* 6*d.* post free anywhere in the world. Single numbers 1*s.* net; single back numbers more than two years old, 1*s.* 6*d.* net; postage (inland and foreign) 2*d.*

Binding cases, price 2*s.* 6*d.* net each; postage 6*d.*

Notes of the Month.

For many years radio-activity—the ability of an atom spontaneously to emit from its depths either a swift alpha particle or an even swifter electron—was thought to be a property confined strictly to the very heaviest elements. The speculative view that all the elements are radio-active has had to be turned down entirely through lack of evidence. Above a limit represented by lead and bismuth everything heavier was radio-active, everything lighter was inactive. The first blow to this simplicity occurred nearly twenty-five years ago when the common and light elements, potassium and rubidium, were found to be radio-active. The radio-activity occurred, however, to a very small degree indeed, and it was the less important particle, the electron, which was emitted in both cases.

* * * * *

Now comes news from Professor G. von Hevesy's laboratory at Freiburg in the Black Forest that another light element, this time a very rare one called samarium, is not only radio-active but that it emits the really important and fundamental particle, the alpha particle. If this observation is confirmed, the discovery becomes an important one, because it suggests that the unstable atomic structures of the very heaviest elements may not be so rare as has hitherto been supposed. Samarium has an atomic number 62 and a mass of about 150. Chemically it is a "rare earth." Its neighbouring element, 61, is so rare that it is still doubtful if it has yet been discovered, although it has been provisionally named "illinium." It is just possible that the excessive rarity of elements in this neighbourhood may be connected with instability of structure which shows itself as radio-activity.

* * * * *

Major Bagnold's expedition to the Libyan Desert, which has lately returned to Cairo, is noteworthy on two accounts. First, because it penetrated farther into the desert than any point previously reached by white man, and, secondly, because it demonstrated the possibilities which exist for the motor-car in this type of exploration. It was the longest journey hitherto undertaken in the desert by car, all the equipment being carried without mishap over a distance of 1,600 miles. The objects of the expedition, which were fully realized, included the exploration of unknown land, the demarcation of certain boundaries, and much botanical, geological and archaeological research. The territory covered ranged from the Oweinat Oasis to Tekro in French Equatorial Africa. In traversing unmapped regions, a special sun compass invented by Major Bagnold was used. The expedition closely explored the "oasis" near Oweinat, seen from the air earlier this year by Sir Clayton East Clayton, and found that the plateau described by the airman consisted of volcanic craters. It is hoped that Major Bagnold will contribute an account of the expedition to *Discovery* on his return.

* * * * *

Captain Riiser Larsen, the Norwegian explorer, has just completed plans for an expedition by sledge to the South Antarctic. The explorer, who will be accompanied by two companions, is taking eighty dogs, and hopes to reach Enderby Land before the end of February. He will then travel westward to the Weddell Sea, a distance of 3,500 miles. Nearly 2,000 miles of this journey will lie across almost unexplored regions. Captain Larsen is chiefly concerned with geographical exploration, but he will also make a series of observations in connexion with the International Polar Year. While making final preparations

for the expedition in London, the explorer briefly outlined his plans to the Press. He explained that during aeroplane flights along the coast of the Antarctic continent he had observed a tight row of stranded icebergs over a considerable distance. Between these icebergs and the " fall " of the inland ice the sea ice lies unbroken, and apart from the snow drifts the cover of the ice is suitable for sledging. Captain Larsen said that he hoped to solve the question of whether there is an opening from the Weddell Sea, through unknown regions, to the Ross Sea. The expedition expects to return early in 1934.

* * * * *

The Scott Institute at Cambridge has for some years been the centre of Polar research in this country, and has already established itself as a national institution. Plans have now been prepared by Sir Herbert Baker for the erection of a new building, but the Institute is likely to embark on its full career with a serious handicap. In a letter to the Press, Sir Hilton Young and Professor Frank Debenham, the director, point out that the sum available for building is insufficient to carry out the plans in full, and for the lack of £2,000 it will be necessary to leave the building for the present without its top storey. This will not only be a serious handicap to the efficiency of the Institute, but will make completion more expensive in the long run. It is hoped that those who recognize the scientific and economic importance of Polar work, apart from its appeal to the imagination, will be able to help its future scientific home to start unhandicapped.

* * * * *

Some months ago the possibility of wireless communication on a wave-length of less than one metre was demonstrated, when messages were sent between Dover and Calais, employing a wave-length of approximately eighteen centimetres. A " micro-ray " equipment has now been perfected for the Air Ministry, which will operate on a wave-length of about fifteen centimetres. Aerials of less than one inch in length are used, and micro-rays, oscillating at a rate of about 2,000,000,000 times a second, are generated in a special " micro-radion " tube. The equipment will be used at Lympne Aerodrome for announcing the arrival and departure of cross-channel aeroplanes which are not fitted with wireless apparatus. A feature of this service will be the use of teleprinters for receiving and transmitting messages. The teleprinter was described as a modern miracle by Sir Kingsley Wood, the Postmaster-General, in a recent review of technical developments at the Post Office. Dealing with the application of this invention to the telephone system, he said that in the near future subscribers would be able to switch over to the teleprinter and proceed at once to exchange typewritten messages.

* * * * *

For some time past we have published unsigned book reviews in accordance with the best journalistic practice. Our reviews are written by experts, but unlike articles on original research they reflect the opinion of the journal rather than of individuals. (A signed review often tempts its author to air his own views, instead of giving unbiassed criticism.) In our December issue, however, some controversial statements were inadvertently admitted on the subject of stag-hunting. On a debatable subject of this kind *Discovery* cannot express any views but is solely concerned with facts ; and we should be sorry to think that any reader may have supposed that the journal was " taking sides " on this question.

* * * * *

Important new facts regarding the discovery of Peking Man were given for the first time in this country by Professor Davidson Black in his Croonian lecture to the Royal Society. It was Dr. W. C. Pei who discovered the two now famous skulls in material from a cave at Choukoutien, near Peking. Other fragments found at various times have lately been described. The bone from the left wrist confirms the human character of Peking Man ; and a cast of the interior of the brain case points to the fact that he was capable of articulate speech. The stave implements found are evidence that Peking Man attained a use of the hand which compares with that of modern man. One point in Professor Black's address is particularly interesting, that is the remarkable length of the period during which Peking Man inhabited the cave. Relics are found throughout no less than thirty metres of undisturbed deposits. Peking Man was, therefore, living in the cave during the whole time that these deposits were being laid down—probably for thousands of years. The deposits as a whole belong to one cultural phase of early Pleistocene age. It is gratifying to note that the Chinese Government is keenly interested in the investigations, and that the Geological Survey has purchased the cave so that it may be preserved to science.

* * * * *

The problem of deciding under which heading edible birds' nests imported into this country might suitably be classed for purposes of duty has been solved by a facetious official, who suggests that they should be regarded as building materials !

The Progress of Medicine—I.

The Leprosy Problem and Its Solution.

By Maj.-Gen. Sir Leonard Rogers, K.C.S.I., F.R.S.

As founder of the British Empire Leprosy Relief Association the author's work in connexion with the disease is well known. In the following review of recent advances, he puts forward a plan for the rapid reduction of leprosy in the Empire. This will be followed by further articles dealing with progress in other branches of medical research.

It is only in very recent years that the seriousness of the leprosy problem in the British Empire has been realized even by those most conversant with medical matters. A little more than a decade ago the outlook for the unfortunate leper was so hopeless that the medical profession were loathe even to discuss the problem of dealing with this justly dreaded disease. Innumerable remedies had been tried in vain in its treatment, and the repeated failure of confirmation of various claims to have discovered a remedy had led to a very discouraging scepticism of all such attempts. Nor can we yet claim to possess a curative treatment of the majority of confirmed advanced cases. But sufficient therapeutic progress has been made in the last decade or so to have opened up a new era of hope for the leper that has completely changed the position of the problem. So a brief general account of the recent advances should be of interest at the present time.

One result of the much greater recent interest in leprosy is the discovery that there are far more persons afflicted with the disease than was formerly known, when our only information concerned the advanced easily recognized forms of the disease, such as then formed the vast proportion of admissions to leper asylums. Recent investigations, more particularly by Dr. E. Muir in India, has shown that there are anything from two to five patients in the early little recognized stages of the disease for each advanced one. Space does not permit me to go into details, but a conservative estimate made by the British Empire Leprosy Relief Association, which I founded in 1923, placed the lepers in our Empire at over half a million, mostly in India, but at least 150,000 in our tropical African Colonies and smaller numbers, such as from 5,000 down to 500, in South Africa, the West Indies, Malaya, Ceylon, British Guiana, Mauritius, Fiji, etc.

In my Cameron Prize Lecture before the University of Edinburgh in October, 1929, I discussed the recent advances in the treatment of prophylaxis of leprosy, and summarized my survey of the older methods of treatment in the sentence " none of the very numerous remedies referred to could be relied on to clear up an appreciable number of leprosy cases, although occasional favourable results have followed the use of some of them." It was due to this lack of any curative treatment of leprosy from Biblical times up to a decade or two ago that led some countries to cling to the cruel compulsory segregation methods of the Middle Ages, aided by the survival of the erroneous public belief that leprosy is a highly contagious disease. Actually the truth is that it is far less easily communicated than the more deadly tuberculosis, which no one would attempt to deal with by compulsory segregation.

As a matter of fact only two to five per cent of healthy persons living for years in the same house as a leper actually contract the disease, although as many as eighty per cent of cases do result from such house infections. It is the absence hitherto of any effective treatment of the disease—together with the deformities resulting in advanced long standing cases, with loss of fingers and toes in the little infective nerve form, and gross thickening and redness of the skin of the forehead, ears,

AN ADVANCED CASE.
A photograph taken in Kenya of a native suffering from the disease in an advanced stage.

face, etc., in the more infective skin type of leprosy—that has led to the survival of compulsory segregation. This is nothing short of imprisonment for life, as a rule, for the crime of innocently contracting a disease which is so greatly dreaded by the healthy.

In Tropical Countries.

In Norway a mild and humane form of isolation has led to a slow reduction of the disease since 1856, but under the less favourable conditions in such tropical countries as Hawaii, the Philippines, the West Indies, Malaya, Fiji, etc., and also in South Africa, there is no very clear evidence that it has served to bring about any material reduction of the incidence of the disease. Nor is the reason far to seek, for in the Philippines it was found that the cases of the disease isolated under the compulsory segregation laws averaged eight years' duration, and in South Africa they have been officially stated to have been of "four, six, or more years' duration, and some of them past their most infective stages" when first discovered and sent to leper asylums. Thus in both countries the patients had mostly had from four to eight years in which to infect others before themselves being isolated, because with nothing but a life sentence of imprisonment in view the unfortunate patients naturally hid their condition as long as possible.

In the absence of any effective treatment, this cruel segregation method was the only available measure, and at least it could do little harm; but this is no longer the case, now that the great majority of the early cases can be cleared of all symptoms and rendered uninfective to others by the modern methods of treatment, compulsory segregation can easily do more harm than good, by leading the early amenable cases to hide themselves until they have past the most curable stage of the disease. Thus, I have seen several patients who came 6,000 miles from South Africa to be treated for leprosy in London because they dared not consult a doctor at home for fear of imprisonment for life.

It is a remarkable fact that nature has provided specific remedies for some of the greatest scourges of humanity—quinine, the active alkaloid of cinchona bark, for malaria and emetine, that of ipecacuanha root, for amoebic dysentery; both vegetable substances discovered ages ago by ancient South American races. Similarly the ancient Indian remedy for leprosy is chaulmoogra oil, containing chaulmoogric and hydnocarpic acids with a peculiar closed ring constitution. This is present in the seeds of Taraktogenos kurzii of Burma and in those of several species of Hydnocarpus trees growing in the Western Ghats of south-west India and through Siam to Indo-China. This remedy was introduced to European medicine by Mouart of the Madras Medical Service as far back as 1854, but it proved to be too nauseating to permit of its being taken orally in sufficient doses to do more than retard the progress of the disease.

In 1913 Dr. Victor Heiser and Dr. Mercado in the Philippines injected the oil intramuscularly with slightly better results. It was at Dr. Heiser's own suggestion that the writer of this article resumed investigations on the subject in 1915, and found that by the simple method of making the sodium salt or soap of the fatty acids of hydnocarpus oil, a soluble preparation was obtained. This could be safely injected intramuscularly and intravenously, with the result that reactions in the diseased tissues might occur with breaking up and eventual disappearance of the leprous bacilli from the affected tissues. Far better results were thus obtained in a considerable series of cases by prolonged treatment, especially in early cases. Soon after, Hollmann and Dean in Hawaii confirmed this work and advocated a slightly different compound, ethyl ester hydnocarpates and chaulmoograte. It was also shown by Californian workers that the preparations introduced by the writer had the power of inhibiting the growth of acid-fast bacilli belonging to the same group of bacteria to the causative organisms of leprosy and tuberculosis, but not so acting on other classes of bacteria, thus indicating a specific action in leprosy, and they are also not without promise in some of the more chronic forms of tuberculosis.

"Skin Clinics."

The early reports of this improved treatment of leprosy not unnaturally aroused much scepticism, chiefly among those who tried it mainly in unsuitable and very advanced cases. But it has now passed beyond the realm of controversy, for no less than one thousand of the five thousand advanced cases in the great Culion leper settlement of the Philippines were reported in 1927 by Drs. Wade and Lara to have been cleared of all symptoms and infectivity. Arrangements were then made to treat earlier cases at special hospitals and at "skin clinics" without sending them to Culion. Within a comparatively short time a second 1,000 cases were cleared up; a number of recoveries never dreamed of up to a decade ago. The importance of early treatment is well brought out by the classified results in among 486 Hawaii lepers, for the recovery rate was only eight per cent in very advanced cases, 38 per cent in

moderately advanced ones, but no less than 64 per cent in the early stages. It should be mentioned that relapses occur, but usually yield again to further treatment.

In 1923 the writer founded the British Empire Leprosy Relief Association, with H.R.H. the Prince of Wales as Patron, Lord Chelmsford, former Viceroy of India, as Chairman, and Mr. Frank Oldrieve, formerly of the Mission to Lepers in India, as Secretary, for the purpose of organizing relief measures in the numerous and extensive leprosy-afflicted areas of our Empire. Soon after, Lord Reading, when Viceroy of India, issued an appeal which resulted in obtaining about £150,000 for the endowment of the work of the Indian Branch of the Association. Only a few of the more important activities of this organization can be mentioned here. The home branch has paid especial attention to the difficult problem of leprosy in our tropical African possessions, in nearly all of which compulsory measures are quite impracticable, but large numbers of lepers have been attracted voluntarily to leper colonies with the provision of land to enable them to cultivate their own food, and where regularly treatment is provided and no less than 1,000,000 doses of the soluble sodium hydnocarpuse have been supplied by the Association in the last two years alone.

In Southern Nigeria a leper colony founded by Dr. Macdonald soon attracted 1,000 lepers, and Dr. Mayer, the expert employed by the Nigerian Government, recorded that within five years nearly 6,000 lepers were under treatment in the various leper colonies and clinics in that territory. In Uganda Dr. Wiggins organized the treatment at five dispensaries built by the Association, and from 2,000 to 3,000 lepers have been attending for weekly injections for several years past. In the badly injected humid southern Sudan, the principal medical officer, Dr. Atkey, organized a campaign for stamping out leprosy, in which a population of over 110,000 persons were examined for leprosy, over five per cent were found to be infected, and no less than 4,800 out of 6,500 discovered have been accommodated in an uninhabited area of thirty square miles where they are largely self-supporting by cultivating the land, and only uninfective cases remain outside the colonies. A recently received report states that 2,230 cases of leprosy have been discharged during the last year

WAITING FOR TREATMENT.

Natives afflicted with leprosy waiting for admission to a clinic in Nigeria. (Leprosy Relief Association photos.)

as free from all active signs of the disease, and a very difficult leprosy problem is in a fair way to being solved.

In India about a decade ago only some 7,000 lepers were being cared for in numerous leper asylums supported by the provincial governments and the Mission to Lepers. But they were nearly all advanced hopeless cases, cast out by their relatives and most of them no longer infective. Their isolation therefore did extremely little to reduce the incidence of the disease, as they had infected others of their households long before they were themselves isolated. Before he left India in 1920 the writer was fortunate enough to obtain funds for financing a whole time leprosy research worker in the Calcutta School of Tropical Medicine which he had founded. He was still more fortunate in getting Dr. E. Muir to take up the work, who has since then trained over 1,000 medical men in the new treatment of leprosy. Dr. Muir has carried out surveys in various provinces, combined with propaganda and the opening of very numerous leprosy clinics. Here patients can be treated at the cost of half a crown a year for the drug, against £200 a year per head expended in New South Wales on the compulsory segregation of each of their lepers. The last received report from India showed that 50,000 lepers were attending these clinics in Madras and the Central Provinces alone, or seven times as many as were in the various leper asylums in the whole of India about a decade ago. It will require several decades of steady work to bring about a material reduction of leprosy in India. But now that the great majority of the very early cases can be cleared up by regular weekly treatment for from some months to a year or more, we have in our possession the means to reduce the disease much more quickly wherever the following plan can be carried out.

Fighting the Disease.

The plan suggested by the writer several years ago for the rapid reduction of leprosy in any area where it is feasible to carry it out is based on the two following conclusions, arrived at from a very close study of the literature of this disease. Firstly, as already stated, at least 80 per cent of infections are the result of living, usually for a long time, in the same house with a leper; and, secondly, the incubation stage—that is the time after exposure to infection before the disease develops—is less than five years in at least 80 per cent of cases. It follows that when a typical leper is discovered, all the members of his household should be examined from head to foot for the earliest signs of the disease, and those discovered should be treated regularly in the early, and often uninfectious, stages of the affection. This house examination should be repeated at least every six months for five years, by which time 80 per cent of possible house infections would be discovered in the early curable stages and nearly all cleared up before they went on to become infective to others. After a second period of five years this plan would reduce the incidence of infectious cases of the disease to small proportions, for in ten years most of the advanced infectious cases would have died or passed into an uninfective stage.

A Successful Campaign.

That this plan is feasible has now been proved in the case of a terrible epidemic of leprosy in Nauru Island in Oceana. Here the disease spread so rapidly among a small population of some 2,000 persons, who had been weakened by an epidemic of influenza combined with a deficient diet, that when at the writer's suggestion this plan was put into operation an examination of all the people revealed that no less than 30 per cent were infected. Nearly half were already in an infectious stage, and they were kept under treatment on one side of the island. As a result, after three years the medical officer in charge, Dr. G. W. Bray, was able to report that the total number of cases showing symptoms of leprosy had been reduced by no less than 40 per cent, and no single early case had gone on to the infective stage.

Another report a year later showed that 50 per cent of the isolated infective cases had cleared up and returned to work, and the epidemic is now in a fair way to being cleared up. When we compare this dramatic result with the continued widespread prevalence of leprosy in Hawaii, New Caledonia, and the Loyalty Islands, in the same area fifty to eighty years after similar epidemic outbreaks, the success of the improved treatment properly applied in Nauru is most striking and encouraging. Arrangements have just been made for applying the new plan of campaign in another British Island possession with 200,000 people under an experienced leprologist paid by the British Empire Leprosy Relief Association.

If this effort also proves successful within the next decade, there will be no further excuse for delaying the general adoption of the great advances in the treatment and prophylaxis of leprosy, which have accrued within the last sixteen years as the result of the investigation of British and American research workers. Leprosy will then be robbed of most of its terrors and will cease to be the dreaded scourge it has been for over two thousand years.

A Thousand Years of Bohemian History.

By Karel Guth.

Director of the Archaeological Department, Prague National Museum.

The revolution of October, 1918, which made the city of Prague once more the capital of an independent state, incidentally opened up a wealth of antiquities to scientific study. The excavation of Castle Hill reveals a continuous history of at least a thousand years. Dr. Guth's manuscript is translated by the Rev. C. M. Macleroy.

THE urgent work of adapting the buildings of the long neglected Castle Hill at Prague for use as the headquarters of government and the residence of the President, made it impossible to attempt more than a cursory archaeological examination until 1925. Even before that time, however, important discoveries had been made, almost by accident, just south of the Golden Gate of St. Vitus' Cathedral, in the course of the reconstruction of the drainage system in 1920. These served to whet the appetite of the experts for the feast which was to follow. A tribute is due to the skill and enthusiasm of the members of the Commission appointed to supervise the work of excavation and preservation. This has been done in the course of the last seven years, and is still continued under the superintendence of my young colleague, Dr. Ivan Borkovský.

The Castle of Prague.

The Castle of Prague stands on an elongated hill of schistose rock commanding the River Vltava (Moldau), and at a distance of some 500 yards from it. At this point the river bends from a northerly to an easterly course, later inclining northwards again. The hill extends approximately east and west, and its north and south sides are steep, the former falling away into the Stags' Moat, the latter towards the left bank of the river on which the Mala Strana, or Little Side, of Prague is built. The ridge of the hill in its natural state was very irregular in contour. Its highest point was a little to the south of the west front of St. Vitus', and thence it sloped gradually eastwards, being crossed by a ravine running north and south, just under the Golden Gate of the cathedral. From that point the ridge ascended again towards the Basilica of St. George, and then beyond the cloister-buildings fell away sharply towards the bend of the river. The hill was very bare, and its sun-baked, rain-washed surface sheltered little vegetation, apart from scanty patches of grass in the crevices of the rocks, and some stunted trees in the ravine.

It is noteworthy that no prehistoric remains have been found on the Castle Hill. It thus contrasts with the natural rock-fortress of Vyšehrad, situated on the other bank of the river, about a mile and a half higher upstream, where recently important remains of the Neolithic Age have been unearthed. Vyšehrad is reputed to have been the site of the earliest human settlement in this region, and the cradle of the Bohemian nation, but its records are mainly traditional and legendary. The Hradčany, or Castle Hill, on the contrary has a history virtually as long as that of Bohemia, a history doubly authenticated on the one hand by written documents, and on the other by the more tangible records here described.

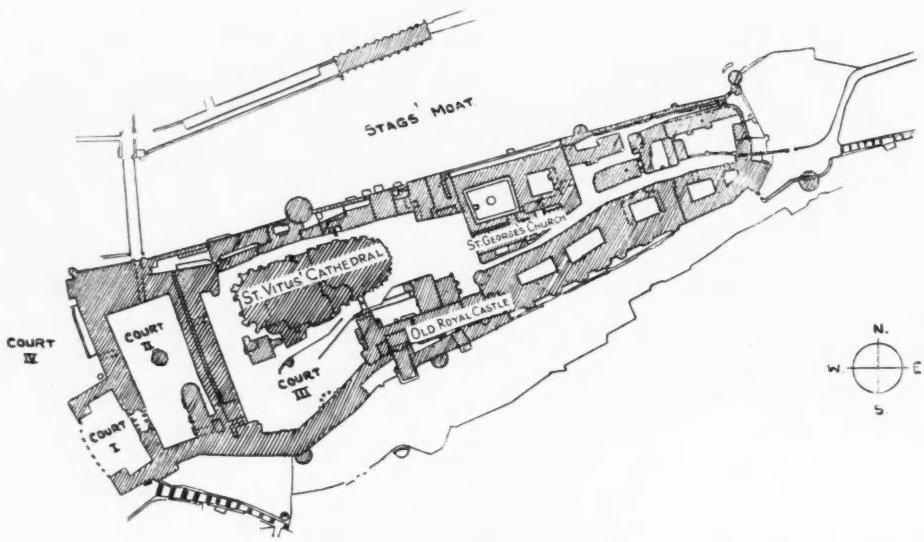
The area of the original fort and settlement on the Castle Hill was much less than that covered by the buildings to-day. What are probably the original ramparts of clay—reinforced by stakes and beams of wood, now exposed and scientifically preserved—can be traced beneath the third court, within the foundations of the present buildings on the south and crossing under the block between the third and second courts on the west. These ramparts have been entirely obliterated on the north, doubtless through the erection of the successive ecclesiastical buildings. The eastern limits are uncertain, but it is probable that they traversed the site of the cloister and basilica of St. George.

There was a gate at the south-west corner of the fortifications, and the path leading up from it to palace and church can be traced by its paving of schist-splinters and flints. At the east end there was another gate, to which a steep path led up from the river, and there was probably yet another gate situated about the south-east corner, which connected with a path coming up over the southern cliff, and still used in the sixteenth century.

Solemn Ceremony.

The oldest princely palace, doubtless of wood, stood probably near the site of the great Vladislav Hall of to-day. No suggestion of a possible site west of this has presented itself in the course of our excavations, and certainly all the mediaeval palace-buildings were confined to the area east of the cross-ravine. To the north of this palace stood the stone throne—about the east end of the present cathedral—on which every new prince even up to the twelfth century was set with solemn ceremony, to be confirmed in his dominion.

As early as the tenth century—our chief literary authorities for the early history are the Chronicles of Kosmas and the so-called Christian Legend of Vaclav (Wenceslaus)—there were three Churches on the Castle Hill. The first, dedicated to the Virgin, of which no trace has been found, is to be attributed to the first Prince of whom there is historical record, Bořivoj, in the second half of the ninth century. The second church, dedicated to St. George, was founded by Prince Vratislav in the year 915: it was, like the first church, built of wood. The third was of stone, in form a rotunda, built about 929 by the famous Prince and Saint, Vaclav, and dedicated to St. Vitus. Its remains still exist beneath the floor of the present cathedral, with the grave of Vaclav in the most southerly of its four apses—a spot now sacred to the whole nation.



GROUND PLAN OF PRAGUE CASTLE HILL.

To the third church, according to the records, a burying-ground was attached, situated on the little knoll between the church and the western ramparts. Here human remains have been found, layer over layer, in great abundance. One grave of unique interest was uncovered in July, 1928: it had evidently been covered by its separate mound of earth. Within it there rested on a wooden surface the skeleton of a tall, well-made warrior, his sword, dagger, axe, fire-flint on either side of him, and near his feet the remains of what seems to have been a water-bucket. Most experts interpret these features as pagan survivals into Christian times. In any case a date is indicated for this burial earlier than the time of the aggressively Christian Prince Vaclav, who would have tolerated no vestige of paganism; and one somewhere about A.D. 900 has found favour. This would correspond with the time usually assigned for the Christianization of this region.

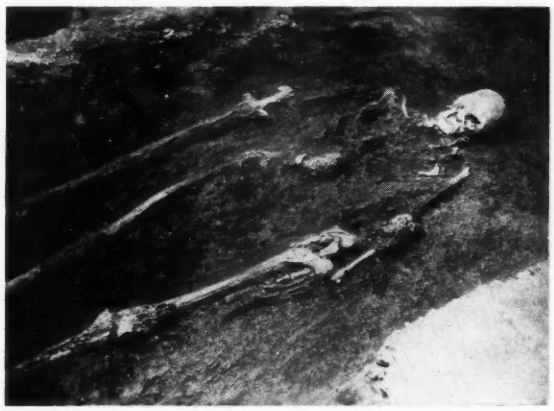
All the early dwellings and churches stood, as has been indicated, east of the cross-ravine. Within the ravine and between it and the western ramparts there were wooden houses occupied by the common people—"hewers of wood and drawers of water"—and two groups of these have been unearthed, one in front of the west façade of St. Vitus', the other to the south of the Golden Gate. In places as many as three layers of such houses have been discovered. In some cases the doorways and partitions of these diminutive dwellings are extant, and even in one case the trough from which the domestic pig was in the habit of eating his dinner a thousand years ago.

In A.D. 973 St. Vitus' became the seat of a bishop, and at St. George's, to the east of it, a cloister of the Benedictine Order was founded. It was not, however, till the reign of Brětislav I (1034-55) that much change took place in the appearance of the hill top. This prince substituted for the out-of-date ramparts, new ones of more elaborate construction. On the edge of the cliff an immense wall of clay was heaped up, sloping down into two folds separated by channels; this was perhaps protected by palisades. The upper fold culminated in a breastwork formed of clay, and

behind that there was a strip of board-fence. Above this, in a moderate fold inclined backwards, rose a wall of plain stones, forming a protection for the great clay-rampart behind it. The inner rampart, with the wall of stone, gave backwards into the court, behind the line of the oldest fortifications. Outside of the western rampart a broad ditch was dug.

A further important change in the appearance of the area now covered by the third court occurred through the extension of the stone buildings to the west of the cross-ravine. In the first half of the eleventh century a small chapel, afterwards dedicated to St. Maurice, was built, and close by, the Bishop's house, which was reconstructed in the second half of the twelfth century. In 1060, as we learn from the records, Spytihněv II (1055-1061) tore down the rotunda of St. Vitus and began the construction of a new basilica, with triple nave in the South German pattern. This his brother and successor, Vratislav II (1061-1092) completed. This church had two choirs, with crypts beneath, and in the west choir a transept. Its whole ground-plan, together with remnants of columns, was exposed in the course of the reconstruction and completion of St. Vitus' Cathedral, which went on intermittently between 1861 and 1929. A portion of this structure, under the south wall of St. Vitus', is now open to inspection from the third court. Towards the middle of the eleventh century also the wooden huts were demolished, and the burial-ground beside the west ramparts fell into disuse, two new burial-grounds being laid out beside the bishop's chapel and alongside of the great church.

Another change, perhaps the greatest of all, came about in the days of Soběslav I (1125-1140), when the clay ramparts were displaced by fortification-walls



THE WARRIOR'S GRAVE.
This burial, containing the remains of a warrior with his sword, was among the most interesting finds.

THE CASTLE HILL.
A view of Prague Castle and the Cathedral of St. Vitus, overlooking the river Vltava in the foreground.

of stone, and the hill fort of early historic times became a mediaeval Romanesque castle. The new walls, fortunately for the archaeologists of to-day, were not built on the line of the ramparts on the south side of the third court, but further to the south. They have been discovered along their whole length under the south wing of the present palace-buildings. The west wall is hidden under the wing which divides the third court from the second, along with the " white tower " which protected the castle gate. This gate was at that time moved westwards to the south-west corner of the fortifications. The castle itself was also extended eastward to the then newly-built " black tower," so that in this part it attained its present extent.

Within the new walls a new palace was then built, the whole under-storey of which is preserved in the cellars under the Vladislav Hall : all this has now been cleared of rubbish and made accessible. By the demolition of the upper part of the ramparts, and the partial filling-up of the cliff and of the cross-ravine, a level surface was formed, which the mediaeval spirit could not long leave bare. And so, towards the middle of the twelfth century, on the site over the ravine, a small Romanesque church was built, consisting of a single nave. Then towards the end of the century a gangway of stone was added extending from the north side of the church to St. Vitus'. On this a burial-place was laid out, perhaps for the clergy of St. Vitus', since in one of the graves a small late-Romanesque bronze cup has been found, together with a paten, similar to the cup used by bishops in connexion with a portable altar. To the west of the gangway, and in front of the west gate, there was at that time a small Romanesque stone building, square in plan, which was probably a tower. There was a

similar erection outside of the castle, in what is now termed the fourth court, close to the Archbishop's palace. Soon after the middle of the twelfth century, too, the Monastery-Church of St. George was re-built; it had two crypts, as well as elevated choirs, and galleries over the side-naves.

Important alterations and additions were made to the buildings on the Castle Hill in the thirteenth century. A small late-Romanesque building of two rooms discovered beside the south castle wall in the third court belongs to this period. A large structure in the south-west corner of the same court, the foundations of which have been traced beside the west castle-gate, may probably be dated about the end of that century. Most considerable of all were the changes made in the fortifications, which were strengthened by means of bastions on the south, and by three lines of deep trenches on the west; of these latter there is a record from the year 1278. The King Přemysl Otakar II, called the "Golden" by his contemporaries, demolished the old palace to its ground-storey and built over this a Gothic structure, part of which underlies the Vladislav Hall of to-day.

Three Chambers.

The most powerful impulse to building on the Castle Hill, however, came with the reign of the great monarch, Charles IV (1346-1378). This ruler demolished the upper part of the palace, already damaged by fire, and built it anew more beautifully, while improving the lower part also. In his plan the space now occupied by the Vladislav Hall was divided into three chambers. Remnants of his archways, window-decorations, wall-paintings and other details are to be seen at different points in the present buildings, and care is taken to leave these remnants intact. Changes were also made in the fortifications. A second wall was added on the south side, outside of the old one; a quadrangular tower was built at the south-west corner of the third court; the defences on the north side, over the Stag's Moat, were extended, the great four-cornered tower on the edge of it being added; and the whole system of fortifications was completed, according to the standards of the age.

This most illustrious of Bohemian monarchs, who has left his mark upon the city of Prague as no other has done, was not content to be the builder of palaces and fortifications, however splendid. His highest ambition was bound up with the faith which was the ruling motive in his life. First one architect and then another yet more gifted were summoned to build for him a vast Gothic cathedral, which should be the crowning glory of Prague the Golden—so called by reason of the gilded towers and roofs which Charles loved. It belongs to the pathos of his life that he saw no more than the beginning of his greatest enterprise, and that only after five and a half centuries, in the year 1929, was it completed at last.

Our present concern is with the relics and remains of the first half of the millenium of Bohemian history written in bold characters upon the Castle Hill of Prague, since these alone belong to the realm of recent discovery. The records of the second half of that millenium—from the fifteenth century onwards—in stone and brick and plaster, have long been familiar and need no description here. Certain epochs in those last five hundred years are especially notable because of the changes which they brought in the general appearance of the Castle Hill. There was the age of Vladislav (1471-1516), who gave his name to a special type of "Gothic," which is represented by the splendid Vladislav Hall.

There was the age of the Renaissance proper, when both Czech and foreign architects and artists changed the whole face of things, and reduced the irregular complex of buildings to a classical unity and uniformity. There was the spacious age of Maria Theresia, when architecture, civil and religious alike, was pervaded by Baroque motive and style (1757-1775). Then followed the long reign of neglect and decay, lasting until the Revolution of October, 1918, when Prague became once more a seat of government, and the Castle Hill awoke, with all its old charm and beauty, to a new and vigorous life. Which of all the world's capitals can show a more complete and continuous record of a nation's history throughout a thousand years?

Photo-Electric "Talkies."

A NEW system of reproducing sound by photo-electric means was demonstrated last month to scientists and engineers in Madrid. It is the invention of two Spanish engineers, who claim that the system is an important advance on the present methods of producing talking pictures. The photographic development of the sound ribbon is less costly, and the new system is said to register sounds of higher frequencies. At the demonstration in Madrid sound films made by the new process were exhibited, and a photo-electric reproduction of a gramophone record was also heard. This was compared with the performance of the record when played in the usual way, and the clearer amplification resulting from the new method was at once appreciated.

The Need for a Biological Outlook.

By Sir Michael Sadler, K.C.S.I.

Last month we referred to the National Conference on "The Place of Biology in Education," promoted to focus attention on the comparative neglect of this science in the schools. The national and imperial need for a biological outlook was the subject of an address by Sir Michael Sadler, on which the following is based.

FOR a statesman to plan a policy for his people without having in his mind the biological aspects of its history, its breed and its place in the world is to risk misdirection. Imperial representatives assembled in conference to frame a statute for the British Commonwealth, but paying no regard to the hints given by biology, would be like an assembly of prehistoric turtles lying under palm trees on our London clay and blissfully unobservant of signs of the coming of the Ice Age. If the pulpit ignores biology, sooner or later there will be empty pews. Trade Unions which think that biology is no part of their business will go the way of the mediæval gilds. And an education which is inhospitable to biology cannot effectively prepare for life.

The claims of biology to a place in the sun have been powerfully urged of late. Mr. H. G. Wells, who has had as great an influence as any living man on the minds of young English people, and Professor Julian Huxley, are doughty champions of biology. They have hammered at gates which do not open readily to new demands. The British Social Hygiene Council has done its part. So have Dr. Jesse Jones and the Phelps-Stokes Commissions. Inspectors of the Board of Education have thrown their great influence into the scale in favour of encouraging the teaching of biology in schools. The Advisory Committee on Education in the Colonies, which meets at the Colonial Office under the aegis of the Under-Secretary of State, has pressed hard for full recognition of the biological standpoint in the development of plans for village and urban education in Tropical Africa.

Favourable Omens.

Both in England and in East and West Africa there has been a distinct improvement in consequence of these agitations. Those who are acquainted with the details report that more English schools are teaching biology and that more headmasters have become interested in its claim to a better place in the programme of school studies. The short courses held at the Universities for the purpose of giving teachers an introduction to biology have been good and valued. On the whole the omens are favourable. That so much progress has been made is due in no small degree to the influence of newspapers and magazines and widely circulated books. Biological ideas are seeping into political thought and into schoolroom technique.

A Beginning.

But only a bare beginning has been made. College scholarships in science at Oxford and Cambridge are still too narrowly confined to physics and chemistry. On the questions involved in any full recognition of biology as a factor in liberal education there is still imperfect liaison between the secondary school masters and mistresses and the teaching staffs of the Universities. The introductory courses held at the Universities are still too short. Secondary school teachers cannot yet get a term off in order to do more systematic work in the subject. And, with perhaps a few exceptions, the high schools of India are still barren of biology.

Mr. J. P. Graham has just recorded his experience as a schoolboy and schoolmaster under the title of "Forty Years of Uppingham" (Macmillan, 1932). Recalling his schooldays, which began in the year after Thring's death in 1887, he writes:—"Our education in school was more in keeping with the school-world immediately surrounding us than with the busy world outside. . . . It seems strange to think that in 1888 every man jack of us was compelled to learn, or more strictly was compelled to be taught, the language of the cultivated Athenian; that the bulk of us knew nothing of the secrets of science; and that the study of French was adequately described by the exclamation of a harried student of the Classics, 'Thank Heaven! at last a slack hour!'"

This eye witness has given a truthful account of the schoolroom cosmogony of Thring's Uppingham. But lessons in form time, important as they are, are only a part of a boy's education at an English public school. Out of school, biological studies were well represented in the fieldwork and written papers of the Uppingham School Natural History Society. As it happens every summer term from 1877 to 1880 I went over to Uppingham from Rugby to the annual reunion of their natural history society and ours. And I remember vividly how much impressed I was by the number of Uppingham boys who were deeply interested in natural history—a number much larger

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in proportion to the size of the school than we could boast of at Rugby though our society was flourishing and numerous.

A *sine qua non* in education is zest. Zest for biology may have taken an amateur home-made form in the lives of Tom Hughes and his brother, but it was as real as the zest which distinguished T. H. Huxley. In country homes, and in many towns, boys developed biological interests in a practical way from what they saw in farm, field or garden, although in school their pedagogues gave them a starveling diet. What was weak was the theoretical, the schematic side. But I venture to suggest that those of us who believe strongly in the virtues of a well-organized, many-sided system of national education should be on our guard against a bookish viewy sort of instruction in biology. One can make as great an ass of oneself with "ideologies" as one can with ignorance.

Our hope that biology will come into its own in English schools is certain to be realized. The trend of thought on educational matters is all in our favour. In October Lord Irwin said at Hatfield how glad he was that the inspector had found among the children of St. Audrey's School "a real spirit of investigation." "To have succeeded in developing such a spirit," he went on to say, "is to have succeeded indeed. It has been achieved by training the children to find in their surroundings the interest which is always there. The teachers are seeking the secret of relating teaching to life." To hear these words must have been a great satisfaction to Mr. E. F. D. Bloom, and to those who are associated with him in giving this biological turn to many schools in Hertfordshire.

The Life Sciences.

There are signs on the Continent and in the United States, as well as less conspicuously in this country, of a measure of disappointment with the results of modern education, signs of dissatisfaction that education, from which so much was hoped, has not made a new moral world. Men's thoughts are everywhere being driven to face the fundamental question: what kind of liberal education is adequate to our modern needs and on what secure philosophical foundation can it rest? In the formula for such a liberal education I have no doubt that the life-sciences should hold a leading place. The more we try, as Plato tried, to integrate, in the development of human power and skill, the training and rhythmic exercise of the body with the training of the emotions and of the analytic and discursive reason, the greater will be the importance which we shall attach to the science of life. We shall be very careful about bringing the dead among the living. But my own mind cannot rest in a philosophy which is limited to a panorama of evolution.

The idea of development is indeed indispensable to us. We cannot live a full intellectual life among stactic ideas. Seen in the light of the idea of development nearly everything takes on a new and luminous significance. No theory of evolution and development can alone supply the whole of the philosophy which should be the matrix of a liberal education. But in all education and in most of our decisive judgments, it is essential that our minds should take into account what biology has proved or hints at.

"Potted Zoology."

Points from other speeches at the Conference are given below:—

Professor H. A. S. Wortley, of the University College of Nottingham.—Too much of the teaching on biological lines in the past had tended to be merely potted zoology and potted botany. When he talked with youngsters of seven years of age he had always found in them a very keen interest in living things. When he interviewed students going into training colleges at eighteen or nineteen he found that in a very large number of cases that interest had gone.

Professor Dame Helen Gwynne-Vaughan.—As long as the country at large understood so little of biology, thousands of pounds would continue to be lost to the nation by such unnatural disturbances of the balance of nature as the introduction of rabbits and watercress into Australia or the more recent case of musquash, which were destroying riverbanks in this country.

Professor Langdon Brown.—There was no single feature in which life appeared to be more extravagant than its reproductive energy. A fish would spawn 2,000,000 eggs. We were too much inclined to imagine that perfectability was Nature's aim. It was not. It was survival.

Mr. F. B. Malim, Master of Wellington.—The Headmasters' Conference would oppose the suggestion that biology should be made a compulsory subject in schools. They were falling into the hands of the specialist, and nobody recollected that his business was to teach the boys. The unfortunate victim passed from one enthusiastic specialist to another without the time or the leisure to digest what he had learned and the inevitable result was that at the end he was not very sure of anything and his mind was full of ill-sorted odds and ends.

Correspondence.

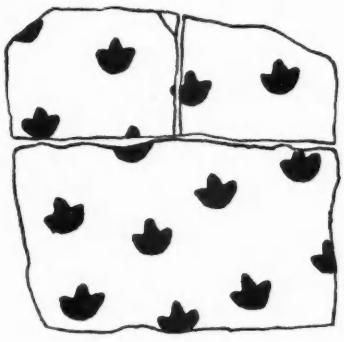
IGUANODON FOOTPRINTS IN DORSET.

To the Editor of DISCOVERY.

DEAR SIR,

In the counties of Dorset, Wiltshire and Buckingham, and on the north coast of France near Boulogne, there are preserved certain deposits belonging to the Upper Oolite period. They consist mainly of limestones interstratified with occasional earth layers, and their fossil contents indicate a country of forests and lagoons. The limestones, for the most part made up of fresh-water shells, sometimes contain marine varieties such as the oyster, from which fact it is evident that the sea of those times occasionally broke in and flooded the lagoons. Life was abundant. There were many varieties of fish, also turtles and crocodiles, and a large extinct reptile known as the iguanodon. Insect life included butterflies, beetles and locusts. The earth beds belong to periods of uplift, when the floor of a lagoon temporarily became dry land. Here lived several species of primitive mammals, all of diminutive size. From their fossilized teeth it is clear that they were all vegetarian or insectivorous. At the fossil forest near Lulworth may be seen remains of the petrified tree trunks of this period.

Early this autumn the three slabs illustrated in the accompanying sketch were obtained from the Middle Purbeck



formation, and come from what is known locally as the Pink Bed. Beneath this bed are some 2 feet of Skirt Bed, Thornback and Sugar Bed, followed by 3 feet of Freestone, whilst it is overlain by about 1 foot 6 inches of Roach Bed. From inquiries it appears that similar stray footprints have been found on previous occasions, but no attention has been paid to them. Traces of others have since been found in the Roach Bed, whilst in another quarry about a third of a mile distant a few footprints accompanied by mud-cracks were found last year on the surface of the underlying Skirt Bed. The slabs present a very fine series of iguanodon footprints, showing the tracks of two animals, or perhaps, to judge from the disposition of the footprints, it may be the complete track of one animal and a part of two others. Each footprint is about 11 inches wide.

The Geological Memoir of the Isle of Purbeck and Weymouth (1898) makes no mention of any such tracks in the Purbeck formation, and they are without question extremely rare.

A good deal is now known about the iguanodon, owing to the unique find of some twenty-two complete skeletons of these creatures at Bernissart in Belgium in 1880. When fully grown they were about 14 feet high, and they walked on their hind legs, which were provided with three toes. Their fore limbs, however, had five toes each, and these they probably used to grasp the branches of trees, for like many other large reptiles they did not eat flesh. In this country their fossilized bones have occasionally been found in Sussex, the Isle of Wight and elsewhere, but it is rarely that more than two or three bones are found together. A visitor to the Natural History Museum at South Kensington can see a cast of one of the complete skeletons from Bernissart.

Yours faithfully,

J. BERNARD CALKIN.

Wychwood School,
Bournemouth.

THE BIRDS OF DOMINICA.

To the Editor of DISCOVERY.

DEAR SIR,

I have read with much interest the article in your November number entitled "An Extinct Bird Rediscovered." Possibly some ornithologist, whose attention has thus been aroused, may be able to throw further light on the subject.

I find by my diary, written at the time, that it was on February 27th, 1922, that I sailed down the west coast of Dominica. Suddenly I remember calling my companion's attention to a flock of most interesting and unusual birds. He said he had often noticed them in that locality, but that no one had been able to tell him their name. They were flying to and fro, in front of a steep cliff rising above the sea. It was a gorgeous, calm day, and they were very clear.

The wings were widely spread, and to the best of my recollection you could see light between the tips—as in the case of an eagle in flight—thus giving a feathery appearance. The triangles of light between the primaries, which I had twice seen in an eagle, are caused by the weight of the bird's body, which curves the wing tips upwards. These birds must therefore have been of considerable weight. The neck and head were short and heavy, like a parrot's; the tail was much in evidence, and the flight very unusual, reminding me somewhat of a rocketing pheasant. The birds were big, though not as big as the "Frigate" or "Man-of-War" bird, which a friend had pointed out to me a few days before, on the east coast, whose slow flight resembled that of a heron.

There were about eight of these birds in all, and another remarkable thing about them was that they were snowy-white. If they were "Diablotins," which the short thick neck, the widespread wings, the habitat—close to the cliff and over the sea—all incline one to believe, the whiteness is a puzzle, as their colour in your picture is shown as black and white. I have tried hard to discover the name of these birds, but hitherto have gained no light on the subject.

Yours faithfully,

King's Langley,
Herts.

A. F. BRYANT.

(From the description given, it is unlikely that the birds observed by our correspondent were Diablotins. It is more probable that they were Boobies (allied to gannets). There are not many white birds in the West Indies, and those here described could no doubt be identified without difficulty at the British Museum (Natural History).—ED.)

The "Petrified Forest" of Arizona.

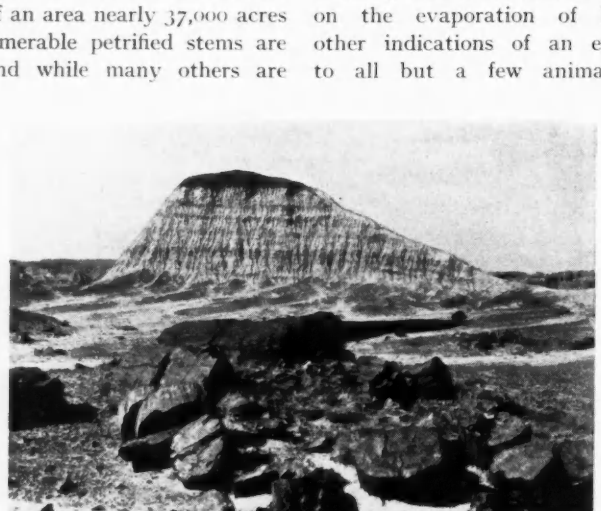
By A. C. Seward, Sc.D., F.R.S.

Professor of Botany in the University of Cambridge.

In DISCOVERY *last October the author discussed the geology of the Grand Canyon. He now deals with another of the famous National Parks in the United States. The fossil trees of the "Petrified Forest" of Arizona are perhaps about two hundred million years old, and form one of the most impressive geological and botanical records in the world.*

THE descriptive term "petrified forest," by which it is customary to refer to an area in northern Arizona reserved in 1906 as a national monument, is misleading; a petrified forest strictly speaking is a forest or part of a forest converted into stone where the trees grew. Though there are many examples of stumps of forest trees in rocks belonging to different geological periods still standing and rooted as they were in life, most specimens of petrified stems occur in old sediments, as flotsam from tree-covered banks or hill slopes bordering a river or an estuary. Whole trees or broken stems and branches fell into the water, and after floating for long or short distances, sank waterlogged into the sand and mud which had been transported in suspension and eventually deposited as the flow of the current was checked. It would be more correct to speak of the petrified stems of Arizona as drift-wood that was buried in sediment more than a hundred million years ago and derived from forests which grew we know not where.

The "Petrified Forest National Monument" includes about fifty square miles of an area nearly 37,000 acres in extent, in which innumerable petrified stems are scattered over the ground while many others are still embedded in the low hills and banks of sand and clay of the semi-arid region. It was the writer's good fortune in the course of a recent tour in the United States to visit the drift-wood area. Through the courtesy of the officers of the Santa Fe Railway Company, the "Californian Limited" stopped at Holbrook, 1,595 miles from Chicago, whence we were taken in a south-easterly direction to the small Museum in charge of the Park Ranger close to the entrance to the reserved area, a distance of about twenty-five miles. The dry barren country was brightened by patches of a small blue and white lupin a few inches high; to the south was a range of well-wooded hills.



THE "PETRIFIED FOREST"

In the foreground are blocks of broken stems. In the distance is a cliff of Triassic sediment, a relic of the mass which formerly covered the whole area.

The geological age of the Arizona sediments and trees is that known to geologists as Triassic, a name chosen to indicate the fact that in Germany, where the rocks of this period were first described, the formation, consisting of sedimentary strata, is divisible into three parts, a lower, a middle, and an upper series. In England only the lower and upper series are represented and very few fossil plants or animals have been found. Triassic rocks are the chief sources of salt obtained from Cheshire, Worcestershire, and elsewhere. In many parts of the world the rocks of this period afford striking evidence of desert and semi-arid conditions; sand dunes, rocks that were conspicuous as cliffs in the Triassic landscape, furrowed and polished by blasts of sand, beds of rock-salt and other minerals deposited on the evaporation of briny inland seas, and other indications of an environment unfavourable to all but a few animals and a scanty flora.

In some parts of Europe and in Virginia in the United States, Triassic sediments belonging to the later stages of the period are rich in plants; there were regions of the Triassic world where conditions were favourable to the growth of forests. The Arizona fossils are proof of the existence of dense forests of well grown trees reaching a height of 200 feet or more. It has not hitherto been possible to assign the petrified stems to a definite stage of the

Triassic period, but some specimens of fern fronds and leaves of plants that it is customary to designate Cycads, despite their remote affinity to existing members of that group, have recently been found in Arizona, which appear to be identical with forms characteristic of the upper or Keuper series. These specimens were shown to me by the officer in charge of the museum and it is hoped they will soon be described.

A PETRIFIED TREE TRUNK.

Part of a large petrified trunk laid bare by the erosion of the Triassic sediment in which it was embedded. The photographs were taken by Professor Seward.

Some of the prostrate stems reach a length of nearly 200 feet and a diameter of 8 feet; some are broken into great cylindrical blocks, recalling the rows of detached drums of Greek columns overthrown by an earthquake at Olympia; others show evidence of crushing under pressure while the wood was still in its natural state. Specimens in European museums have made many people familiar with the wonderful colouring of the petrifactions; brilliant red, shades of blue, yellow and white; some are almost black, others light grey. The preserving material is silica, which was gradually deposited, presumably from hot water, in the tissues of the tree; it is stained with iron oxides and other natural dyes. Cracks and cavities in the silicified wood are lined with gem-like crystals. A large cylindrical block in the British Museum with a richly coloured surface conveys a good idea of the appearance of many of the stems which have been converted into chalcedony, amethyst, and other forms of crystalline silica. Most of the stems are littered over the dry sandy ground; some still lie in the enclosing contemporary sediment in which the dead wood was infiltrated with petrifying waters Logs protruding from the faces of cliffs furrowed by infrequent cloud-bursts, aided by wind, have been partially uncovered by the removal through denudation of the comparatively loose sediment which formerly concealed the stems and was spread as a thick mantle over the whole district.

As one looked over the arid waste strewn with stems of huge trees, which after centuries of forest life had been turned into columns of gem-like quartz, the landscape seemed to change into a level plain flooded with water, bearing on its surface bleached and branchless trunks which one by one sank into the soft muddy ooze. Somewhere in the distance, how far away we do not know, were groves of stately trees reaching to the edge of a strongly flowing river.

Of what sort were the trees? The late Dr. Knowlton of Washington, from a microscopical examination of thin sections of the wood, ascertained that some of them were closely related to the genus *Araucaria*, now confined in the western world to Brazil, Chile and parts of the Argentine, and in the east to the Australasian region and islands still more remote. Two kinds of *Araucaria*, the monkey puzzle (*Araucaria imbricata*) of the Andes, and the Norfolk Island pine (*A. excelsa*) are familiar as widely cultivated trees; the former flourishes in the open in many parts of Britain and the latter has been introduced into southern Europe and many other countries where the climate is more genial than in England. Our knowledge of the Arizona trees is meagre; much work remains to be done before we can attempt to describe the nature of the Triassic forest or compare the extinct trees with conifers which are still with us. All that can be said at present is that some of the trees were related to *Araucaria*; all of them, so far as we know, were members of the great Conifer group, which includes pines, larches, junipers, cedars, firs, yews, as well as *Araucaria* and other genera.

Scenes now being enacted often help us to reconstruct a remote past. The Sante Fe route to the west, shortly after crossing the Arizona-California boundary, passes by a picturesque and fertile valley at the foot of the San Bernardino Mountains; a view from the train of the broad and gravelly bed of an attenuated river, which recalled the dry channels and flood-plains on the southern edge of the French Maritime Alps, with bleached and weather-beaten stems and branches piled by floods against barriers

(*Continued on page* 30.)

New Research on the American Indian.

Whether or not the American Indians belong to the same racial group has hitherto been an open question. A new study of the hair and its racial significance has just been issued by Mr. and Mrs. Woodbury, of Colorado

SINCE the times of Herodotus and Aristotle, and even before, the appearance of the hair has been recognized as one of the most distinctive of racial criteria. But this study was limited to the outward appearance only until the early part of the nineteenth century, when the development of microscopic technique afforded a better and more accurate method of investigation.

Two Schools of Thought.

There are two schools of thought about the hair of the North American Indian. One holds that it is uniformly straight, black and coarse; this is the more popular conception and assumes that all Indian tribes are of the same race and are descendants of the Mongoloid peoples of Asia. The other holds that there is a non-uniformity among the Indians in general and that there are various types of Indian hair, assuming, in consequence, that not all Indians sprang from the same racial group.

On examining the literature of the subject, however, it seemed to Mr. George Woodbury, of the State Museum, Colorado, to be inadequate to support either of these rival contentions. Two years ago, with his wife's assistance, he began an investigation into the whole problem and their preliminary report* throws much interesting light on the American Indian tribes.

The head hair on the desiccated body of a Cliff Dweller from Mesa Verde, in the collection of the Colorado Historical Society, provided the original impetus to this research. Specimens of Mesa Verde hair as well as hair from living Indian tribes were added until the work reached considerable proportions. It has been thought best to publish the first results now, although the authors explain that much more material remains to be examined, as the microscopic investigation of American Indian hair is far from complete.

The study of human hair began seriously in 1822, when Hensinger first brought the revealing power of the microscope to bear upon its characteristics. In that year he cut and examined cross-sections of the head hair of a negro, and was the first to recognize the kidney-shaped appearance characteristic of this race. Weber, in 1826, carried the microscopic study a step further. He examined the cross-sections of hair of several different races, and concluded that straight hair was round in section, while curly hair was elliptical. In 1843, Henle wrote the first detailed study on this subject and outlined the hypothesis that the degree of waviness in hair was directly related to the degree of flattening of its cross-section. In other words, he demonstrated that the wavier a hair, the more elliptical would be its cross-section. Kölliker, in 1856, showed that an elliptically shaped hair tended to curl toward its flatter side. In this way the hypothesis of the relation between hair form and shape of cross-section developed, and it has come down to the present time, with but slight modification by subsequent research.

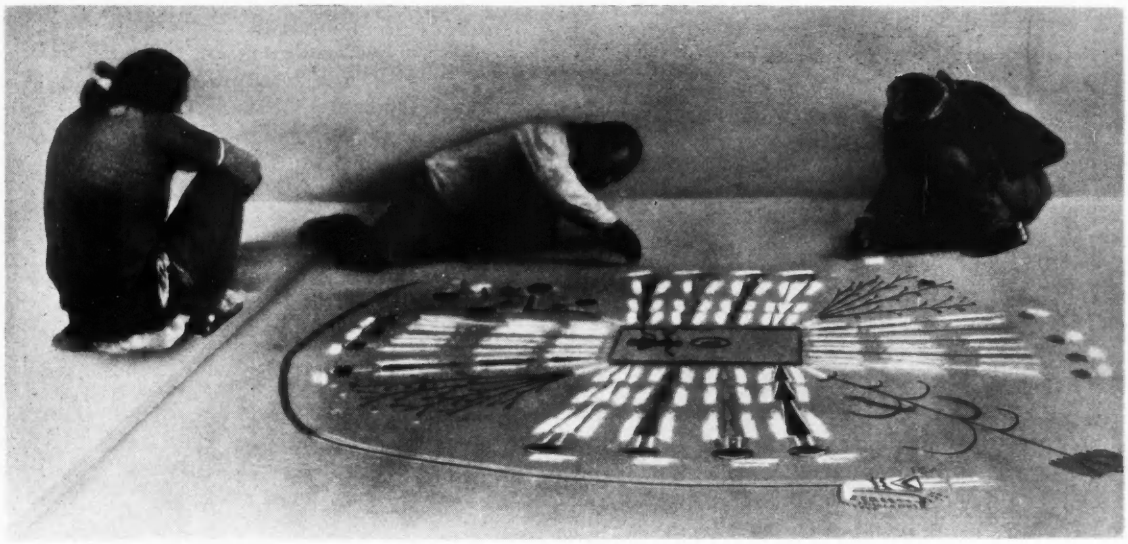
The first investigator of American Indian hair by the microscopic method appears to have been Peter A. Browne of Philadelphia. His "Examination and Description of the Head Hair of the North American Indian and its Comparison with the Other Varieties of Man," appeared as a contribution to Schoolcraft's "Archives of Aboriginal Knowledge" (1860). Browne examined cross-sections of Indian hair under the microscope and concluded that it was all either "cylindrical or cylindroidal." He added that this fact indicated that all Indian hair was naturally straight, and thereby corroborated Henle's hypothesis that the straightness or waviness of hair depended upon the shape of its cross-section. He concluded that the "peculiar, *lank* appearance of the hair of the head of the American Indian is owing to its cylindrical form."

Physical Characteristics.

As these conclusions have, and for that matter still do, influence our conception of the physical character of Indian hair, it is of interest to see upon what evidence Browne based these important views. The specimens of Indian hair that he examined represent ten individuals in all. The cylindrical specimens were from a Choctaw Indian, a Texas Indian, and a Sac man, also specimens from mummies from Lima, Pachacamac, Arica, Pisco, Mexico and Brazil. The cylindroidal specimens were from a Choctaw woman.

A few years later Pruner-Bey (1863) in Paris undertook a comprehensive study of the racial characteristics

* *Differences Between Certain of the North American Indian Tribes as shown by a Microscopical Study of their Head Hair.* By GEORGE WOODBURY and EDNA T. WOODBURY. (Published by the State Historical Society of Colorado State Museum, Denver, Colorado.)



NAVAJO INDIANS.
The Navajo Indians of New Mexico were among the tribes studied by Mr. and Mrs. Woodbury.

of hair including American Indian material. Two groups of Indians are represented in his tables: "2 Américaines du Nord" and "6 Guarani." Their index values are given as "81" and "77" respectively. Since the index value is an expression of the form of the hair cross-section, we see that these two tribes were not found to be exactly alike.

In 1888 the German anthropologist, Gustav Fritsch, stated that from his experience Indian hair was characteristically slightly wavy, dark brown in colour and not at all coarse. He further stated that there were intertribal differences to be noted among the various tribes in the United States, but admitted that his study was inconclusive through lack of abundant material. Ehrenreich pointed out in 1897 that among the Brazilian tribes that he had examined, straight, black coarse hair was by no means general.

In 1908 Latteux appeared as collaborator in Chervin's "Anthropologie Bolivienne." From measuring the specimens of head hair collected from the Aymara and Quéchua tribes, he concluded that they were fine, black and slightly oval.

After this brief historical sketch Mr. and Mrs. Woodbury explain that, to decide between the rival conclusions previously reached, they set themselves to find out if American Indian head hair is of one uniform type or not. If it is not, how many types are there and in what respects do they differ? How greatly do they differ and what is the anthropological or racial significance of this difference?

The specimens used in this study represent 156 individuals from twelve Indian tribes. Ten of these tribes are present living Indians and two are prehistoric—the Mesa Verde and the Basket Maker.

In selecting these specimens a number of precautions were observed. In the first place all samples were cut from the *crown* of the head. In the second place they represent full-blooded individuals of adult age. In the third place only those tribes indigenous to the western and south-western parts of the United States were included, for the purpose of giving geographical unity to the investigation. Some of the series are numerically small, but were considered to be of such intrinsic interest that they were included with the larger series and for the most part gave statistically satisfactory results.

The numbers of specimens and tribes used were :—

20 Navajo (New Mexico)	6 Ute (Utah, northern division)
15 Shoshoni (Wyoming)	10 Arapahoe (Wyoming)
19 Hopi (Arizona)	10 Paiute (California and Nevada)
10 Gros Ventre (Wyoming)	16 Basket Maker (Arizona and Utah)
20 Sioux (North and South Dakota)	11 Mesa Verde (Colorado)
7 Comanche (Oklahama)	12 Chippewa (Minnesota)

The authors explain that their Basket Maker material from Grand Gulch, Utah, and from Canyon del Muerto, Arizona, was found to be similar to the point of identity. Both groups were therefore pooled together and treated as one tribe of Basket Makers. It has not been possible as yet to secure a good series of material from the Pueblo Indians of New Mexico, but it is hoped to do so in the near future.

In examining the hair samples, the technique usual in histological work for material of this character was employed. The hairs were embedded in a semi-solid preparation, sectioned by a microtome and mounted. The hairs were sectioned at right angles through the mid-part of the hair shaft, avoiding both the free tip and the bulb. Ten hairs from every individual head of hair were examined on account of the variations in form and texture. From these figures a mean calculation representing each person's head of hair was obtained.

Diameter of Hairs.

All measurements were made with a standardized micrometer ocular under a magnification of 385x. Micrometer readings were converted into micra (.001 m/m.); the standard unit of measurement throughout this report. The maximum and minimum diameters of each hair cross-section were measured and from these two figures the form and texture were computed.

No difference between the head hair of the two sexes could be determined. Male and female specimens were, therefore, pooled together and whenever possible, an equal number of the two sexes were represented in each series.

In analysing the material at hand the first step was to examine the form of the hair shaft. The form of the shaft is determined by the measurement of the two diameters of the cross-section—the maximum and the minimum. These two diameters are computed as an index which is the expression of the form of an object by means of a single figure, as follows :—

$$\text{Index} = \frac{\text{Minimum diameter} \times 100}{\text{Maximum diameter.}}$$

Oval cross-sections indicate wavy hair and round sections indicate straight hair. Therefore, since a low index value represents an oval section and a high index value represents a round section, it is possible to identify wavy and straight hair by a consideration of the index values alone.

Curly hair gives a mean index value of 50.00 to 75.00 and straight hair a mean index of 80.00 to 100.00 Therefore, we may say that wavy hair, being intermediate between these two extremes, will have a mean index of 75.01-79.99. This is the classification of hair form that has been used and may be tabulated as follows :—

Curly hair	50.00— 75.00
Wavy hair	75.01— 79.99
Straight hair ...	80.00—100.00

Among the tribes studied no example of curly hair was found.

The next main consideration in this analysis was the hair texture typical of these tribes. Although there are various methods and formulae for calculating this quantity, the one recommended by Martin was used throughout. It is, in brief, the average of the two diameters of the cross-section, the maximum and the minimum, and is expressed :—

$$\text{Texture} = \frac{\text{Maximum} + \text{Minimum diameter}}{2}$$

Mr. Woodbury points out that no classification could, however, be found that set the limits to what values they should consider fine and what coarse. It was, therefore, necessary to make one. The most frequent mean range in texture calculated by this formula is found to be 60.00 to 110.00 among Hominidae. The classification they have used was made by bisecting this range. The smaller half has been designated as representing fine hair and the larger coarse.

60.00— 84.99 ...	Fine hair
85.00—110.00 ...	Coarse hair

Following this explanation of the technique employed, the authors give many detailed tables showing its application to the specimens of hair and the results obtained. Between these twelve Indian tribes, real differences in both form and texture were found. Both wavy and straight hair appeared, as well as fine and coarse. By using these four headings the tribes may all be grouped under their proper title of wavy-fine, wavy-coarse, straight-fine or straight-coarse, as shown in the following table :—

CLASSIFICATION ACCORDING TO THE FORM AND TEXTURE OF THE HAIR.

Form.		Texture.	
Wavy hair	75.01 — 79.99	Fine ...	60.00— 84.99
Straight ...	80.00 —100.00	Coarse ...	85.00—110.00

Wavy-Fine.	Wavy-Coarse.	Straight-Fine.	Straight-Coarse.
Navajo	Shoshoni	Gros Ventre	Ute
	Hopi	Sioux	Arapahoe
		Comanche	Paiute
			Basket Maker
			Mesa Verde
			Chippewa

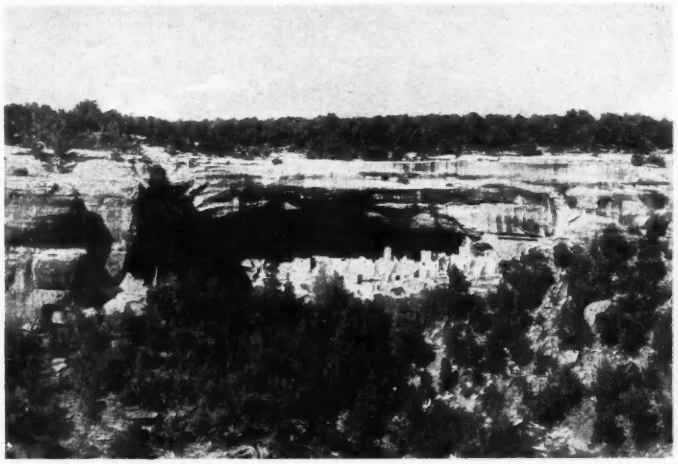
Prehistoric Tribes.

An interesting item is noticeable in the behaviour of the two prehistoric tribes in this classification. The Basket Maker hair falls into the category of the straight-coarse. It has, however, a distinct tendency toward the straight-fine since its texture is so near the border-line between the fine and coarse. The Mesa Verde hair falls into the category of the straight-

coarse also, but has a tendency toward the wavy-coarse, its form being almost exactly between the divisions of straight and wavy.

Both of these prehistoric tribes, therefore, straddle the classification as regards one feature and do not fit as neatly as do the present living tribes. Is it not conceivable that we may have in the Basket Maker and the Mesa Verde prototypes that may have become altered in the passage of time?

Turning now to the anthropological meaning of these differences, the question to be answered is whether these differences are of the magnitude of group differences or whether they are of the magnitude of racial differences under the same group. (In this report the term "group" denotes one of the four largest divisions of mankind: White (European), Negroid, Mongoloid and Composite. "Race" designates one of the subdivisions within a group.)



THE HOME OF THE CLIFF DWELLERS.

Among the American Indian tribes whose hair was studied were the Cliff Dwellers of Mesa Verde, Colorado. The illustration shows a typical cliff dwelling. The houses were built in caves.

In order to answer this, the authors have had to resort to a comparison with non-Indian material. Two races from different groups have been examined and compared. The Mongoloid group is represented by a series of eleven Chinese specimens from Kwangtung, South China. The White (European) group is represented by a series of thirteen white Americans from Denver, Colorado. These two series were selected, examined and studied in exactly the same way as the Indian series.

It was found that although the four types of Indian tribes do differ materially from one another, they do not differ to as great an extent as the Mongoloid and White (European) groups. It appears, however, that the Indian exhibits a stronger affinity toward the Mongoloid group.

The Mongoloid type of head hair is shown by a study of South Chinese and Japanese specimens to be non-uniform. The hair of these two races is not identical. The definition of the Mongoloid type of head hair must, therefore, be made sufficiently flexible to include some degree of waviness, a small range in texture and a colour ranging from black to dark brown.

Mr. Woodbury next deals with the hair colour. The prevailing opinion seems to be that all American Indian hair is black. There are, however, some dissenting opinions and the statement is often met with that brown and even reddish-brown hair has been observed among full-blooded Indians. This has been answered, usually, in two ways. One answer hitherto offered is that the presence of anything but black hair is proof, *ipso facto*, that the individual in question is not a full-blooded Indian. This would, it seems, rather beg the question. The other answer generally brought forward is that the action of direct sunlight tends to bleach naturally black hair to a rusty brown. Experiments in the matter of bleaching were carried out, and although dark brown hair could readily be bleached in this way to a lighter brown, naturally black hair could not be made to bleach to a brown colour. Mr. Woodbury adds that this may, nevertheless, be possible with more adequate laboratory facilities than were at his disposal, and it should be worth further investigation.

Perhaps the greatest factor producing this disagreement of opinion is the lack of any method of measuring hair colour that renders negligible the personal equation of the observer. It is understood that research into this technical phase is now being undertaken, but as yet the results have not been published. Another factor is whether the hair was observed by reflected or transmitted light. This is a matter of considerable importance. In the anatomy of a hair, the outer sheath of the hair shaft is composed of a semi-transparent keratin-like substance. When this is coated with oil, either natural or artificial, which is usually the case among Indian specimens, a reflecting surface is established and the hair appears darker than it really is. When, on the other hand, a beam

of light is transmitted through the hair, this element of reflection is substantially modified and the true pigment colour may be observed. Although it may seem a trite precaution to suggest, washing is essential toward obtaining a true picture of hair colour in either event.

Colour of the Specimens.

In investigating the colour of the specimens, Mr. Woodbury explains that those from the present living Indian tribes were sent in individual envelopes. Frequently the entire envelope would be so saturated with oil from the specimen contained in it as to be completely opaque. The hair from the prehistoric specimens was found to be much browner in colour than was the case with specimens from the present living tribes. It was noticeable, also, that they were not oily. Doubtless, any oil that might once have covered them had long since disappeared. The prehistoric hairs may have faded through time and conditions of burial, but on this point no data could be found.

The results are given in the following table :—

PERCENTAGE FREQUENCIES OF BLACK AND BROWN HAIR.

Tribe.	Black.	Brown.
Arapahoe	88.8	11.1
Sioux	85.0	15.0
Hopi	68.4	31.5
Shoshoni	66.6	33.2
Ute	50.0	50.0
Gros Ventre	50.0	50.0
Chippewa	50.0	50.0
Paiute	40.0	60.0
Basket Maker ...	12.5	87.5
Navajo	4.5	95.5
Comanche	0.0	100.0
Mesa Verde	0.0	100.0

These observations were made on specimens that had previously been washed in dilute alcohol and were then examined by transmitted light. It is interesting to note the considerable variety in percentages here recorded, and that even in the series having the blackest hair, there are to be found some brown specimens.

Finally, the authors give a comparison of the classification of the Indian tribes by the hair with their classification by linguistic stocks.

The Navajo, who are in a separate category by themselves as being of the wavy-fine hair type, are the sole representatives of the Athapascan linguistic stock in this material.

The Shoshoni and the Hopi, who are both in the wavy-coarse category, are both members of the Shoshonean stock.

In the straight-fine type there are the Gros Ventre, Sioux and the Comanche. The Gros Ventre and the Sioux both belong to the same linguistic family, the Siouan, but the Comanche belong to the Shoshonean. At this point the two classifications fail to coincide.

In the straight-coarse category are the Arapahoe and the Chippewa, who are both Algonkin. Also in the same category are the Ute and the Paiute who are both of the Shoshonean stock. There are naturally no data on the linguistic stock of the two prehistoric tribes and so they must be left out of this consideration.

As far as this material goes, therefore, it is found that the classification by hair and the classification by linguistics coincide except in the case of the Shoshonean linguistic stock. But the authors conclude that possibly the members of this stock may not be as genetically closely related as their language might imply.

Evidence for the Expanding Universe.

THE observational evidence for the expansion of the universe was discussed by Dr. H. Knox-Shaw, Radcliffe Observer at Oxford, in a recent lecture to the Royal Institution. The results of astronomical observation, he said, were often quoted as supporting the theory of the expanding universe. It was therefore of interest to consider to what extent the data furnished by our telescopes were definitive, and in particular how closely we could be said to know the rate of the expansion. The nebulae lying beyond our galaxy stretched away into space further than our present limit of penetration. Most of them were so faint that they could be studied only with our largest telescopes. For our knowledge of their distances and motions we were indebted largely to the work of Dr. Hubble at the Mount Wilson Observatory.

The absorption lines in the spectra of the extra-galactic nebulae were shifting towards the red in a way that suggested that they were all moving away from us with velocities which increased with the distance. Whether there was an alternative explanation of these shifts, said Dr. Shaw, was a question for the physicist rather than for the practical astronomer, but if we assumed that they actually indicated motions of recession, we found that the velocities of the nebulae were proportional to their distances from us, as would be required in a uniformly expanding universe. A cluster of very faint nebulae in Gemini, so remote that its light had taken some 135,000,000 years to reach us, had recently been photographed at Mount Wilson, and seemed to be moving away from us at the immense speed of 24,000 kilometres a second.

The Fate of Colonel Fawcett.

By W. S. Barclay, F.R.G.S.

The Churchward expedition to Central Brazil, which lately returned to this country, combined a search for Colonel P. H. Fawcett with survey work among the tributaries of the river Araguaya. Mr. Barclay discusses the problems involved with special reference to the hostile tribes encountered in the little-known plateaux of Matto Grosso.

> "My favourite form of literature is accounts of mountaineering exploits. I do not care how badly they may be written, so long as the writer will walk along the edge of a precipice, with a fall of thousands of feet on one side and a sheer wall on the other. They remind me of bits of country I have been through, where you walk along a narrow line of security with gulfs of murder looming on each side and where, in exactly the same way, you are as safe as if you were in your easy chair at home, so long as you get sufficient holding-ground; not on ground in the villages inhabited by murderous bush cannibals, but on the ideas in those men's and women's minds."—
>
> From *Travels in West Africa* by Mary Kingsley.

The Ill-fated Party.

THE seven-year-old mystery of Lt.-Col. P. H. Fawcett was summarized in the June number of *Discovery*. The party were last heard from at Dead Horse Camp, Lat. S. 11° 43′, Long. W. 54° 35′, some 200 miles north-east of Cuyaba and consequently north of the Divide, or height of land upon the Central Plateau of Brazil, which forms the Plate-Amazon water-parting. The main tributaries flowing from it to the Amazon are, from west to east, the Madeira, Tapajoz, Xingu and Tocantins, of which last-named the Araguaya is the main branch. Their valleys are roughly parallel, but their headwaters are widely scattered across the Divide. Leaving this, they are collected in deep sandstone gorges which lead through successive steppes, down to the true Amazon plain.

This central Divide, running 1,500 miles from east to west, has always been the main highway across Central Brazil. Upon it is located the Government telegraph line which links the coast system with the Madeira-Mamore railway and its terminal ports. The rivers above named have also been traversed for nearly two centuries by Brazilian *bandeiristas*, by missionaries and colporteurs, by prospectors for gold and diamonds and by squatters, but of late years chiefly by traders, who barter goods for rubber and other wild products of the forest, and for skins and hides; in short, for such produce as may be gathered from an almost virgin land by unskilled or Indian labour. Agriculture of a primitive sort exists, satisfying the needs of the scattered local population of whites and mestizos who make up the scattered trading posts, and still more primitive crops are cultivated for their consumption by the Indians.

Brazil's latest census, mostly guesswork, places her aboriginal population at about 4,000,000. What proportion inhabits the northern plateaux it is hard to say, but the number must be relatively large. Colonel Fawcett reported that in the Western Parecis range, he found within a perimeter of forty miles from a given centre, nine cannibal tribes whose numbers he estimated at 146,000. In the river valleys covered by evergreen tropical forest, the soil is intensely fertile and Indian food supplies in the shape of plantains, mandioca and maize, correspondingly abundant. Under such conditions the tribes have less inducement to wander and tend to split up into small units, parted from their neighbours by a narrow no-man's-land. Within these borders they jealously guard their food supply and their womenkind—the two essentials to the tribe's existence—against incursions from without, whether of Indians or white men. Such localization soon induces a differing dialect and even in time a separate speech from that of their neighbours. Thus the number of Indian tongues within the Amazon watershed, as amongst similar conditions elsewhere, presents a very real inter-tribal barrier, despite other local and racial affinities.

Hostile Tribes.

The plateau lands of Matto Grosso are socially classified as Catinga, Chapadao and Sertao. Catinga is deciduous forest, subject to seasonal drought; Chapadao is mixed scrub and savannah; while Sertao is open prairie. Only about 40 per cent of the plateau bears forest. Thus, except where the steppe-lands between the major tributaries merge into the rainy evergreen forest of the Amazon lowlands, their topography offers little real difficulty to travel or exploration. The chief difficulty is finding water on the sandstone surfaces away from the streams. We might wonder therefore why this great area north of the central Divide, covering nearly half a million square miles, should remain one of the least known and worst mapped portions of the American continent. The explanation lies in the number, isolation and mistrust of its tribal units and in the lack of any unifying "lingua franca," such as the "trade palaver" of the African coast tribes, or even

the sign language which formerly obtained amongst the North American prairie Indians.

Bearing these facts in mind, we may review the events connected with the search for Colonel Fawcett since last June. Rattin, the Swiss trapper, claimed to have met a European, possibly Fawcett, in charge of an Indian party well within the main forks of the upper Tapajoz. This occurred 400 miles north-west from the location given by Dyott in the Kuluene-Araguaya section as witnessing the massacre of Fawcett's party. Rattin headed back up-country last July to re-locate and rescue his "white man" and has not been heard from since.

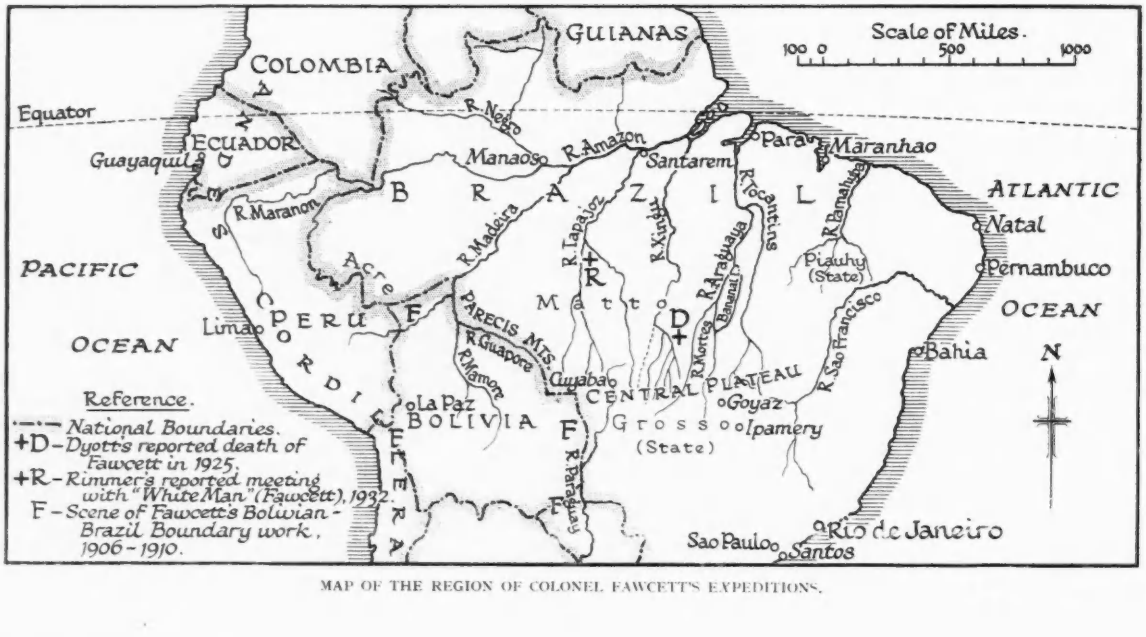
In August, the *Geographical Journal* published independent testimony supporting Dyott's theory, from Mr. Petrullo, archaeologist attached to the Philadelphia University Museum expedition to Matto Grosso during 1931. Mr. Petrullo made an aerial reconnaissance over the Kuluene country, and from this and native testimony places Fawcett's last camp fire at five marches east of the Kuluene, about Long. W. 52½° and Lat. S. 12¾°.

Finally, during August to October, the same Kuluene region was approached, though not entered, by an English expedition, comprising Mr. Churchward, Mr. Roger Pettiward, Mr. Peter Fleming and Mr. Skeffington-Smyth, who were joined in Sao Paulo by Captain Holman and Mr. Priestley. Reaching Bananal Islands on the Araguaya, they persevered to within 100 miles of the Dyott-Petrullo location of the tragedy, which from further Indian testimony as well as from the general aspect of the country, they confirm.

Thus both Government and private search, combined with the silent passage of seven years, weighs heavily in favour of Colonel Fawcett's death with his companions in 1925. Belief in his survival rests only on Rattin's unsupported tale and on the splendid confidence of the explorer's wife. Her faith merits respect as well as admiration, for she shared her husband's plans and his confidence as no one else.

Mrs. Fawcett states that the Dyott report, based on circumstantial and hearsay Indian evidence, is entirely wrong. Her husband explored the Xingu headwaters in 1921, and before he left England in 1925, told her that he did not intend to cover his old ground, but to work north-west, into the Tapajoz country. She claims that the scattered equipment which Dyott found amongst Indian villages from Bakari Post to the Kuluene, belonged to her husband's 1921 expedition, being discarded for convenience *en route*. She inclines to believe Rattin's story from certain personal details in his evidence, but finds its chief confirmation in her husband's original plans. She abandons hope of her son Jack and his friend Rimmel; but she is certain that Colonel Fawcett still exists in the country which he had made his life study. Disabled perhaps, a prisoner almost certainly, but still alive. And in that faith she waits.

An interesting sidelight on this epic is given by a collection of confidential maps, which Colonel Fawcett deposited in the archives of the Royal Geographical



MAP OF THE REGION OF COLONEL FAWCETT'S EXPEDITIONS.

Society, and which Mrs. Fawcett has now released for the general collection. Three of the maps which embody his original field work in 1914 and 1921, are in the nature of samples of the plateau taken close up to its higher levels. The first gives his full exploration of the Parecis range, in the extreme west of Matto Grosso. A middle section shows the Tapajoz and Xingu headwaters and a portion of the Central Divide. The third, the plateau's eastern outlier, in Bahia State, near the river Sao Francisco, in civilized country. Colonel Fawcett certainly believe that the central plateau of Matto Grosso, especially its northern extension, could be converted into a "white man's country," as with the Kenya plateau in Africa. Internal evidence from his maps shows that he had already covered most territory on the upper Xingu and part of the western Tapajoz. Upon these streams he notes carefully in red ink the location of some twenty-five separate Indian tribes. Existing gaps in his knowledge would certainly incline him, both as an explorer and an enthusiast for the country, to work westward rather than eastward. But here all is only conjecture and silence.

Nevertheless Fawcett's death, if indeed he has died, gave that impetus towards exploration of the great Plateau for which he strove. Other expeditions will follow his footsteps, as they have already done. Yet since geography claims to be "the study of earth as the home of man," it would be senseless to map the mere topography of these regions without also studying the tribes which inhabit it.

Studying the Natives.

The passage quoted at the head of this article goes to the root of the matter. Mary Kingsley's lonely travels in equatorial Africa, amidst fever-haunted reaches of the Ogowe river, with the cannibal Fans whom she deliberately chose as her companions, make her journeys half a world away yet curiously akin to those of Fawcett. Miss Kingsley's insistence that knowledge of the workings of the native mind must accompany all successful native administration is now a keystone of British Colonial policy. But for such understanding, let us repeat, there must be mutual speech.

The collection of so few as one hundred common words or signs may prove to be the linked rope which will save the explorer, poised on the psychological *arrete* which is his first encounter with a hostile tribe. These dangerous first half-hours Fawcett faced not once but a dozen times. In the end, possibly for lack of some such small support, he lost footing and was gone.

Marconi's New Experiments.

In an address to the Royal Institution, the Marchese Marconi described his new experiments with ultra-short waves in wireless communication. He said that the new system was working successfully between the Vatican City and the Papal Palace at Castel Gandolfo. That was an example of what would be a new and economical means of radio-communication free from electrical disturbances, and eminently suitable for use between places separated by moderate distances.

Many Uses.

The new system was unaffected by fog, and offered a high degree of secrecy, by virtue, principally, of its sharp directive qualities. In regard to the limited range of propagation of these micro-waves, the last word had not been said. It had been shown that they could travel round a portion of the earth's curvature to distances greater than had been expected. In any case, the new system was now available for advantageously replacing optical or light signalling in all its long-distance applications.

Other applications such as broadcasting and television were already under consideration, and the study of the new fields of application for these so far unutilized electric waves would soon bring about the design of greatly improved methods and apparatus.

Long experience had taught him not always to believe in the limitations indicated by purely theoretical considerations or even by calculations, for these were often based on insufficient knowledge of all the relevant factors, but, in spite of adverse forecasts, to try out new lines of research, however unpromising they might seem at first sight. About eighteen months ago he decided again to take up the systematic investigation of the properties and characteristics of very short waves, in view of the advantages which they seemed to offer—the small dimensions of the radiators, receivers, and reflectors necessary for radiating and receiving a considerable amount of electrical energy—and in view also of the fact that they did not suffer interference from natural electrical disturbances such as atmospherics.

The Marchese explained that, following experiments with waves of the order of 50 centimetres length, conducted between his yacht and a station near Rome, the most outstanding result was the successful establishment of communication over a distance of 168 miles on a wave-length of 57 centimetres. All previous distance records of communication by means of wave-lengths below one metre had thus been surpassed.

The Lungfish in Amazonia.

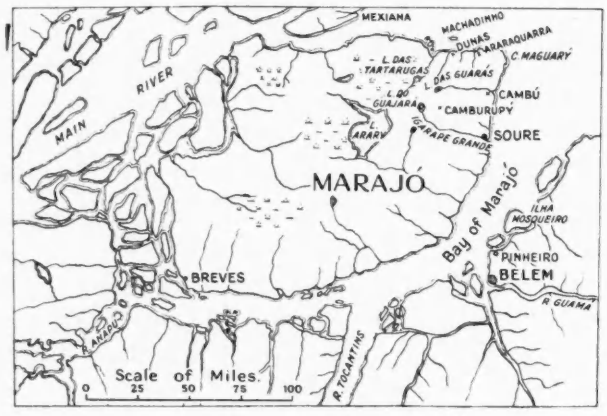
By D. M. Reid.

Department of Biology, Harrow School.

Mr. J. T. Cunningham and the author went to Brazil to investigate certain problems presented by the lungfish during the breeding season. The Amazon region was chosen despite the uncertainty of finding the lungfish there because the Gran Chaco was closed owing to hostilities.

MANY years ago a famous German naturalist recorded the presence of the lungfish in the swamps at the headwaters of the Igarapé Jacaré Magro (the Canoe-path of the Lean Alligator) on the island of Marajó in the mouth of the Amazon. So, our object being to study a certain physiological peculiarity of this lungfish, we set out for Marajó. Of Belem, the chief city of Amazonia and our starting point, I would say little. It is a surprisingly up-to-date place in every way, despite its closeness to the great wilderness of the tropical rain-forest which shuts it in.

From Belem, we took a canoe and sailed across the Bay of Marajó to Soure, the small capital of the island, from which we moved to various places in search of the fish. Despite their propinquity, the climate and consequently the vegetation of the mainland and the island are astonishingly dissimilar. Although on the mainland there is a wet and dry season, they are not of the very hard and fast kind. Almost every day during the dry season there is a shower of rain, and this is enough to supply the needs of the dense forest, where every nook and cranny is made use of in the struggle for existence.



SKETCH MAP OF THE LOWER AMAZON

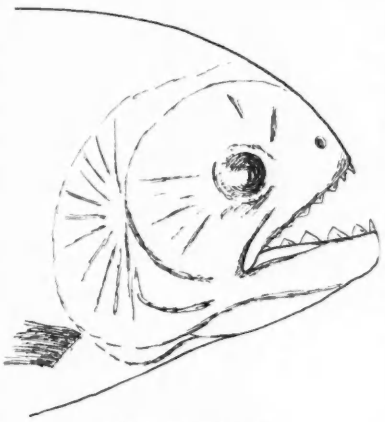
On the island of Marajó, on the other hand, conditions are quite different. The wet and dry seasons are all too clearly marked and the vegetation records it. Great numbers of xerophytic plants are found, since they are able to withstand the drought which may last for some four months, during which the softer vegetation of the mainland would be burned up by the heat of the blazing sun.

Marajó is, in some ways, a very unexpected sort of place to find on the equator in the midst of the great forests of Brazil. It boasts wide stretches of open grassland or campo on which herds of semi-wild cattle and horses graze. It is intersected by innumerable water-ways, the igarapés, along which the tide ebbs and flows, and in which the alligators (jacarés) float lazily and feed on whatever they can procure. Luckily they are very harmless brutes so far as human beings are concerned, although they become a pest in many places owing to their liking for calves which stick in the mud when drinking. There are two species of this alligator found in these waters, the jacaé-assú (*Caiman niger*) and jacaré-tinga (*C. sclerops*). The former grows to quite fair dimensions, about 13 by 15 feet, while the latter is little more than half that size.

Probably the jacaré's inoffensiveness towards man is due more to lack of hunger than timidity. These igarapés abound in fish which supply almost all the reptiles' needs in that direction. That fish do not supply all their needs we found on several occasions by examining specimens we had shot. One had an undigested iguana in its stomach and the other a much digested but quite recognizable younger jacaré. The jacarés themselves are not without enemies; ticks infest them and Indians hunt them for the sake of their tails, which are considered very good—as indeed they are.

The igarapés which intersect the country drain off the bulk of the water which pours over the land during the floods. However, during the dry season that function tends to be reversed to a small extent, for the flood tide running up the igarapé may pour out over quite large areas of land and turn them into permanent swamps. These swamps very often grow great groves of aninga—a plant some eight feet high with bamboo-like stems—which form an almost impassible barrier to man and a breeding ground and sanctuary for snakes.

But the swamps are by no means the only haunt of snakes on Marajó; it is probably one of the snakiest parts of the world. There are snakes everywhere although, of course, one does not meet them at every step, and they are not all harmful. Perhaps the most destructive snake on the island is the jararáca (*Cophias jararaca*) which, although it kills horses and other animals, seldom attacks human beings. The coral snake (*Elaps*) is equally if not more poisonous, but its comparative rarity reduces its significance as a danger to humanity.

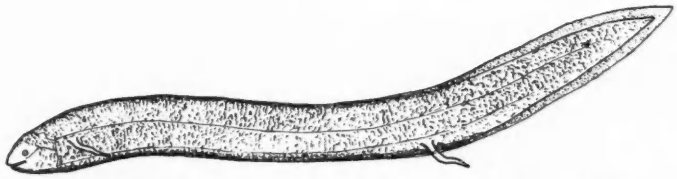


HEAD OF PIRANHA.

Unfortunately for us there is the same confusion in Brazil as in England regarding the local names for animals. Thus in Belem some of the Indians call the lungfish "Trahiram-boia," while others know the coral snake by this name. Of course, we had the bad luck to ask one of the latter people to get us a specimen. He had no difficulty and shook us badly when one morning he calmly and proudly tipped in front of us from a tin a very much annoyed specimen of the coral snake.

The snakes, like almost all the vertebrates, tend to give man as wide a berth as possible, attacking only when they are trodden upon or otherwise frightened. The only vertebrate I can think of off-hand which does not have to be provoked is a fish, the piranha (*Serrasalmo*). This fish infests many of the igarapés in such numbers as to be a perfect menace to any wounded animal which enters the water. Attracted by the blood the piranhas hurry towards their victim and with their large razor-sharp teeth tear flesh from bones in an amazingly short time.

It is important to note that the piranhas do not attack unless attracted by blood, therefore a person with a whole skin may bathe in any piranha-infested water without the least danger from them.



THE LUNGFISH, POSSIBLY A LINK BETWEEN FISH AND LAND ANIMALS.

All the fish of that great water system are not dangerous. Many, like the angel-fish (*Pterophyllum scalare*) look and are extremely gentle under normal conditions. During the breeding season, however, even the angel-fish becomes most unangelic. In this species, as in the case among many fish, the male parent is guardian of the eggs and larvae. The male, however, does not take on the whole responsibility; he acts more as a shepherd, leading the young out of the danger zone while the mother swims round the flock and actively attacks any marauder. Besides this "bulldog" function the mother also sees to it that none of the young strays too far from the main group. If one does wander too far she darts after it and taking it into her mouth returns and ejects it forcefully among its brethren.

Because of the great abundance of fish in the Amazon regions, and the ease with which they can be caught, they form one of the principal articles of food for the inhabitants. There are many methods of fishing, mostly simple and effective. Along most shores the ordinary traps made of split bamboo may be seen. These are of the "funnel" variety common all over the world. When the tide rises the fish enter the trap by the funnel and are left high and dry when the tide ebbs. This is the method employed for the supply of a single family; for commercial purposes on a large scale it is too slow.

The native fishermen take their boats to some narrow, steep-banked igarapé, and having stretched a bamboo screen across it, fix it firmly to the sides and bottom. Then, having carried another screen along the igarapé, they enter the water and drive the fish towards the first screen. The process is accompanied by beating the water with sticks and generally splashing about so as to drive the fish along. When the second screen has been brought thus within some twenty yards of the other it is made fast across the water. Two of the fishermen then take a net between them and scoop out the fish. The sight is almost unbelievable—if the netters move so as to enclose the fish between the net and, say, the bank, the frenzied rush of the victims is almost enough to knock a man over, so great is their number.

The fish so caught are quite small, averaging about one pound or less.

The real standby of the poorer people, however, is a fish of much greater size, the pirarucú (*Arapaima gigas*). This fish frequently attains a length of some six feet or more and is the largest fresh-water fish known. Stuffed specimens exhibited in our museums give but a poor idea of the beauty of the pirarucú. With its enormous shovel-like head and dark scales the size of a crown piece it does not look attractive, but to watch it glide through the water with every scale outlined in brilliant red elevates it from the commonplace to the distinctly beautiful. The flesh of the pirarucú is dried and eaten by the poorer people generally, and owing to its hardness is said to be the chief cause of the defective teeth so common among them.

Tame Specimens.

Marajó is almost a perfect zoological garden if the number and tameness of the exhibits is anything to go by. The tameness of almost all the living forms is remarkable. Nearly every house or hut has its quota of pets which, after a few hours, or a day or two at most, seem prepared to dispute possession with the human inhabitants. In the huts of the Indians this is most marked, for the natives are very gentle towards wild things and are born naturalists. It was to the Indians that we turned to find us specimens of the lungfish.

Lepidosiren paradoxa, the South American lungfish, is chiefly associated in the minds of zoologists with the swamps of the Gran Chaco between Paraguay and Bolivia. In this region the earlier studies were carried out by Graham Kerr and others on the life history of the fish, and very valuable results were achieved. However, during one part of the life history of the organism a phenomenon occurs which is not known elsewhere in the animal kingdom. But perhaps it would be as well to go back a bit and approach the crux in a more orderly manner.

The lungfish, a large eel-like fish, lives in the swampy regions of many parts of South America, and has such structural modifications as enable it to exist during the dry season when the swamps ultimately dry up. The gills have become so much reduced as to be practically functionless while the swim-bladder functions as a lung, so that respiration may be carried on after the manner of a land-living organism. The absence of water being no longer an obstacle to this swamp-dweller, the only danger is desiccation during the very hot dry season, and therefore when the swamps have almost dried up, the fish burrows deep into the mud and there lies comfortably until the rains make aquatic life possible again.

With the advent of the rains the lepidosiren become sexually active; they pair and the female lays her eggs in the bottom of a burrow in the swamp floor. Once the eggs are laid the male parent takes on the work of guarding them and develops on each hind limb a dense brush of highly vascular filaments. Now the question is, what function do these filaments perform? At first sight the obvious answer is "accessory organs of respiration," for the fish is living under reduced oxygen pressure in the hot swamp water which is further deoxygenated by the great quantities of decaying vegetable matter present. But a little consideration will show this explanation to be unlikely, because if the parent has to have accessory organs to get the oxygen necessary to supply his tissues from the stagnant water around the eggs in the bottom of the burrow, he will in a very short time so reduce the available oxygen in the water that the eggs will be suffocated. Hence he would defeat his own ends, for the eggs would stand a better chance of survival if he were not there at all.

Now, turning to the adult fish we find that it has to use atmospheric air normally. Therefore the gills being inadequate it seems unlikely that filaments on the hind-limbs would be any more adequate. So it is reasonable to suppose that these filaments have some function other than respiration. It was to investigate this question that we decided to carry out the experiments.

Oxygen Content.

Our apparatus was simple—a long glass tube was partly filled with water of low oxygen content. This water was sealed off from the air by a thick layer of pure paraffin. Then a fish was suspended in the water and estimations were made of the oxygen content of the water immediately after the introduction of the fish and at intervals for an hour or so thereafter. Of course, the head of the fish was above the layer of paraffin so that its breathing was unaffected. By using female lungfish (which have no filaments on the pelvic limbs) we found in every case that the oxygen content of the water decreased, as also happened with males whose filaments were only partially developed.

In the case of those males whose filaments were fully developed, however, the oxygen content of the water steadily increased. Thus it would seem that these filaments can have but the one function, and one that, so far as is known, is unique in the animal kingdom—the emission of oxygen.

Geography and Modern Problems.

By Kenneth Mason.

Professor of Geography in the University of Oxford.

In his inaugural lecture as first Professor of Geography at Oxford, the author discussed the geographical aspect of modern affairs. He urged the need for a closer study of geography in seeking a solution of current world problems.*

On the framework of our geographical knowledge, however shadowy, we hang many things, all of which go to make up education; and many of us forsake and forget the framework that we knew. Much of the guidance that we have for the future comes from a study of the historical past; but to be of use for the future it must be set in the geographical present. The present has always been the most important moment in geography.

The geographical fact that England was once joined to the continent of Europe was of intense interest to the old importers of megalithic culture to our western shores in the third millennium B.C., but it does not affect the solution of the all-important problems of peace and the limitation of armaments and all that these mean to-day. The geographical fact that glaciers once extended to the Tropics does not affect our environment, our comfort, or our future in the East to-day. The geographical surmise that the Himalaya may one day be eroded down to sea-level makes the task of climbing Mount Everest next year no easier.

To come nearer to the present: the cutting of the Suez Canal has altered the whole geography of the East, perhaps more than the subsidence of the land-bridge between Dover and Calais altered that of the West in prehistoric times; for, to mention one aspect alone of this change, the maritime trade-routes to India have been shortened by 4,300 miles, to China by 3,300 miles, and to Australia by 1,200 miles. And now, the conquest of the air sets problems in geography that must be faced afresh, for mountains and deserts and seas, which formed such obstacles to movement in the past, may to-day be overcome by new methods, using fresh kinds of geographical knowledge to be sought for from such specialists as the meteorologist and the physiologist.

An Array of Problems.

What an array of problems there is to solve. Most of these problems have a definite geographical aspect; I can hardly think of one that has not. The Ottawa Conference had a basic geographical background. The delegates brought their problems from all corners of the earth. The sea-routes and the air-ways brought them half-way round the world. Products, and trade, and industry, and commerce, all deeply involved in economic geography, were dealt with.

Consider the trouble in Manchuria. Surely the geographical facts are of vital importance for any settlement: Japan's proximity to the mainland; the mountainous nature of her own country and the size of her population compared with her arable area; her lack of fuel and raw materials for the industries necessary for her existence; the rich, undeveloped, under-populated lands of Manchuria beyond the Great Wall of China, capable of producing what Japan requires but has not got, and whose development to date is due to Japan's enterprise.

Neglecting Experience.

Has not the neglect to use geographical experience, the neglect to repair the banks that keep a flooded river to its bed, a more or less inevitable neglect resulting from the disorder in the Yangtze basin, been largely responsible for the damage to crops and consequent famines in China in recent years? Is not the future prosperity of large agricultural populations of India, now dependent on artificial irrigation works, similarly governed by man's control of his environment, which is bound to be loosened in times of disorder? Surely these are questions of physical geography? The regrouping of Asiatic states in Turkistan and Trans-Caspia is as certainly an experiment in ethnological geography that must make Afghanistan not a little nervous.

The future of tropical Africa, the clash of interests of Denmark and Norway in Greenland, or of France and Italy in north Africa, as well as a host of other difficulties of to-day, are all problems that the geographer can help to solve. Surely this study of the geographical facts is well worth while, though it must be a hard nose-to-the-grindstone study to get to the bottom of some of them! Some of the facts must still be sought out on the ground, for the world is not by any means yet devoid of secrets. It is the study of geographical facts and their bearing on man that make up geography.

It is the duty of geographers to encourage scientific exploration as far as lies within their power. It is their facts we want, their proved facts—not their

**The Geography of Current Affairs.* (Milford).

theories. A theory in the hands of a novice may become dangerous, for when repeated carelessly it is apt to become accepted as a fact and used as a foundation upon which to build an argument. Such, for instance, has been the fate of the theory of the desiccation of Asia. Drought or desiccation may supply the urge to migrate, but the abandonment of farms and consequent migration, even over large areas, does not postulate desiccation.

Dangerous Theories.

The geographer of A.D. 5000 will not be justified in assuming that the Great War and the Russian Revolution were caused by the abandonment of farms in Turkistan or of homesteads in Turkish Kurdistan, owing to desiccation of these lands in the early twentieth century. Nor is the correlation of glacier-snout movement with Brückner cycles by any means a fact as is sometimes so readily assumed. There can be no general synchronous *periodic* retreat (as distinct from secular retreat) of glacier snouts over a large area, and it is quite possible for the snout of one glacier to be at its maximum advance, while that of its neighbour is at its maximum retreat. Yet such statements that all snouts are advancing together or all retreating together, and that the movement in Asia is synchronous with the movement, or with the climatic cycles, in Europe are constantly repeated. I do not suggest that geographers as a whole accept such statements, but I do urge that none should do so unless they are proved facts.

It is the facts we want: just so many of the facts as are necessary for us to appreciate fully the stage on which man lives his life. We must co-operate with our relatives in science. Our geographical facts are of use to some of them, and some of their facts are of use to us. I have hinted that the world is discovered; but I doubt whether a hundredth part of the land surface of the globe is surveyed in sufficient detail for modern requirements. If the pioneer's day is nearly over, the specialist-explorer's dawn is only breaking. Only when detailed topographical surveys are completed is it possible to survey the ground geologically or biologically or historically in detail; and only then is it possible to make an absolutely complete geographical study of the earth.

In many parts of the inhabited world scientific surveys have not yet been commenced; in others advance has been made and then checked, very often by men who could not read a map if they had it. I do not necessarily mean that these men could not find their way from one place to another with a map. The Beduin of Arabia can find their way across the trackless desert without a map better than most of us can with the most modern maps.

If only administrators would realize what an extraordinarily valuable instrument a scientific map can be, they would not fall over each other in their efforts to destroy the work that had its foundation laid at the beginning of the nineteenth century, merely because the map does not provide, within a year or two, an immediate financial return.

In the wisdom of the nineteenth century there was a Geographical Department of the India Office; and India owes an immense debt to that Department and to its great chief, Sir Clements Markham, who worked in the closest harmony with scientific men in India and co-ordinated their results for the use of the Secretary of State. The appointment no longer exists; but surely a trained geographical adviser to the government of every country, with first-class honours in geography, would be worth his weight in gold.

A hundred years ago it was calculated that the world could only support about 1,500 million people. We have long since passed that figure and are still increasing, thanks largely to the Industrial Revolution, the scientific development of new countries and to discoveries of such world-wide significance as that of the late Sir Ronald Ross. The population is mounting up; development must not stand still.

Geographical knowledge is essential before countries can be economically developed, before roads or railways can be economically built, minerals efficiently exploited, or desert areas rendered fertile. Surely it is the height of unscientific folly to scrap scientific work immediately one is faced by difficulties. Scientific work should be continuous; development cannot be stopped and started again by the pressing of a button, and the shutting down of scientific work in some of our great dependencies is not only terribly wasteful but must undoubtedly lead to still greater difficulties in the future.

An International Study.

Geography is an international study; it is becoming more internationalized every day. In the Empire almost every race and religion is represented, so that our difficulties are always immense, though never insoluble. We can study the past, but not alter it; we can prepare for the future, but not predict it. Drake and Hawkins and Cecil Rhodes may have had their visions of the future, but it was the geography of their own day that concerned them so vitally. In our own sphere of knowledge, it is still the geography of current affairs that counts.

Dinosaurs of the Red Deer Valley.

By W. A. Parks.

Director of the Royal Ontario Museum of Palaeontology.

Recent expeditions in search of dinosaurs and reptiles in the Red Deer Valley of Alberta have yielded important results. Dr. Parks has been prominently associated with the work and here describes some of the outstanding discoveries. The author also reveals something of the elaborate technique required in the field.

THE Red Deer river rises in the Rocky Mountains of Canada, crosses the line of the Canadian Pacific Railway at Red Deer almost midway between Calgary and Edmonton, and continues south and east, a distance of more than 300 miles, to its confluence with the South Saskatchewan river. In its course across the prairie of Alberta, the river has cut a valley to the depth of 400 feet or more.

The strata exposed in the canyon-like walls of the valley are, in descending order, as follows: Paskapoo formation (Early Eocene), Edmonton formation, Bearpaw formation, and Belly river formation. (The last three are Upper Cretaceous.) The Edmonton and Belly River formations are of brackish-water origin; they carry beds of coal and have yielded, also, isolated bones and complete skeletons of fossil reptiles in great numbers. The intervening Bearpaw formation is of marine origin and is without either coal or the remains of land animals.

The first discovery of fossil bones in this district was made by Dr. J. B. Tyrrell in 1887. Since that time expeditions into the region have been conducted by the Geological Survey of Canada, the American Museum of Natural History, New York, the Universities of Toronto, Chicago, and Alberta, and by private individuals.

The prolific locality in the Edmonton formation extends about 25 miles along the river. The still richer Belly river formation has yielded fossils for a distance of 15 miles at least. These beds contain chiefly the remains of reptiles including turtles, crocodiles, and champsosaurs, but they are particularly noteworthy for the great profusion of dinosaurian remains. No other single locality has contributed as much to our knowledge of this remarkable group of animals. Nearly all the skeletons recovered are unique to the locality and consequently represent discoveries that have added to human knowledge. The more important new species of vertebrate fossils from the Red Deer river have been described by Lambe, Brown, Gilmore, C. M. Sternberg, and myself. The specimens are in the Victoria Memorial Museum, Ottawa, the American Museum of Natural History, New York, the Royal Ontario Museum, Toronto, the University of Chicago, and the University of Alberta.

The first expedition of the Royal Ontario Museum was sent out in 1918, and with three exceptions, annual expeditions have been conducted since. The prolific character of the region is indicated by the fact the forty-four major specimens have been obtained, and in addition, much fragmentary material. Thirty specimens, of which fifteen are new to science, have been mounted in the galleries, and, in all probability, the material not yet prepared contains three new species. The American Museum of Natural History obtained about 50 specimens and the Geological Survey of Canada about 40. The Universities of Chicago and Alberta and private collectors account for at least 25 specimens. In all it may be said that 160 to 175 major specimens have been obtained. By "major specimens" is meant complete or nearly complete skeletons and good heads.

THE DUCK-BILLED DINOSAUR.

A species recently discovered in Red Deer Valley, and named "Corythosaurus Intermedius Parks."

Erosion of the banks of the river and of the buttes left standing in the valley expose the buried remains. Unless collected at once, continued erosion soon destroys the skeletons. Actual collecting consists first of prospecting for exposed bones. Having

located a favourable prospect, the overlying rock is carefully quarried away down to the level of the specimen, which is then removed together with the rock immediately surrounding it. The bones are soaked with shellac, and bones and matrix are encased in a covering made of superimposed strips of burlap charged with plaster of Paris. Any attempt to remove a specimen without adequate equipment and experience on the part of the operator leads to inevitable disaster. The plaster-encased specimen is shipped to the laboratory where it is cut open and the work of preparation begun. The matrix is carefully chiselled away and the bones strengthened by repeated treatment with shellac. The isolated and prepared bones or parts are then assembled and mounted. A good preparator is at once a blacksmith, machinist, painter, and worker in plaster and various types of cement. Further, he must have at least a fair knowledge of anatomy.

Dinosaur skeletons when mounted in museums are valuable and impressive objects that play an important part in public education. To scientists, however, it is the discovery of new species, new links in the long chain of life, new evidence of life 50,000,000 years ago, that makes the chief appeal. In this connexion it has been stated already that the work of many authors has contributed to our knowledge of the Red Deer dinosaurs. By way of example, and without disparagement of the much greater work done elsewhere, an account of the new species resulting from the Toronto expeditions follows.

The trachodont or duck-billed dinosaurs of America are related to the iguanodons of Europe, the splendid exhibit of which in the museum at Brussels is doubtless familiar to many readers. Of these inoffensive, vegetarian animals two new genera and six new species have been added to science by the Toronto expeditions. The new genus *Parasaurolophus* is characterized by a remarkable backward prolongation of the bones of the head.

A New Species.

The horned dinosaurs are a group of heavy, low-set forms with great horns on the head and the bones extended back to form a frill over the neck. One new species has been described from our collections. The plated dinosaurs are the most bizarre creatures known. Covered from head to tail with an armour of plates and provided, in some cases at least, with a great bony knob at the end of the tail, they have earned the title of "animated citadels." One new species has been added to science from the Toronto collections.

The great carnivorous dinosaurs, standing twenty feet high on their hind legs, with heads four feet long armed with teeth of six inches, are the most formidable creatures that have ever lived. The best example is the skeleton of *Tyrannosaurus rex* in the New York Museum. A related species from the Red Deer river is in the museum at Ottawa.

An interesting group is the *Ornithomimidae* or bird dinosaurs, so called because they have a bird-like head without teeth. Two new species have been described from the Toronto collections and two others are now being studied. The heads are extremely delicate and fragile. The two best heads in the world are included in our collections. The peculiar, long-tailed, possibly aquatic form, *Thescelosaurus*, is represented by one new species of which the head is preserved. This head is the only one yet found in America. Related forms have been obtained from the Isle of Wight.

In addition to the dinosaurs referred to above the Toronto expeditions have furnished to science new species of turtles and of the reptile *Champsosaurus*.

The "Petrified Forest" of Arizona.

(*Concluded from page* 15.)

of rock, enabled one in some degree to reconstruct the Triassic scene recorded in the sandy plains of Arizona. The enormous number and great size of the petrified trees and the fact that the stems are stripped of branches suggest that they must have been buried in sediment after a long journey from the parent forest. At some places on the coast of Spitsbergen innumerable logs of drift-wood lie on the shore, stems carried by currents from the forests of northern Siberia. Similarly one sees pieces of drift-wood, some many feet in length, by the edge of the sea in western Greenland; they, too, came by river and ocean currents from Siberia.

Many other instances of far-travelled stems might be cited; Professor MacDougal of the Desert Research Laboratory at Tucson, Arizona, described flood-plains of the Colorado river covered for many miles with a mass of drift-wood "so thickly that it is difficult to push a boat through it." So also in the latter part of the Triassic period the land that is now an arid plain covered with wind-swept dust from the crumbling ridges of water-borne sediment may have been a vast flood-plain overspread with denuded and travel-scarred logs. In course of time the logs were buried under protecting layers of sediment and converted by infiltrating solutions into the multi-coloured petrifactions that are now after the lapse of ages protected as a national monument.

Book Reviews.

Concerning the Nature of Things. By Sir William Bragg, O.M., F.R.S.

At Home Among the Atoms. By J. Kendall, F.R.S.

Engines. By E. N. da C. Andrade.

The Mechanism of Nature. By E. N. da C. Andrade. (Bell. 4*s.* 6*d.* each.)

The publishers are to be congratulated on their new " Popular Science Series," of which the four books above are the first to be issued. Each is the work of a scientist of distinction, well known to his fellows in the particular corner of science where he exercises his ability, and known more widely by his ability to communicate to the layman in an interesting and intelligent way much of the beauty and wonder of natural science. Sir William Bragg's book is the substance of the Christmas lectures given at the Royal Institution in 1923-24, and is a reprint of the edition which was first published in 1925. Half of the book is concerned with the nature of crystals, on which the author is the greatest authority in Europe. The rest of the book consists of lectures on atoms, on the nature of gases, and on the nature of liquids. It is one of the most successful popular expositions of these subjects that has ever appeared. It is fully and aptly illustrated.

When we read Professor Kendall's book on its first appearance in 1929 we thought he had overdone the popular touch. We still think so. It is extremely unlikely if the caption " Gentlemen Prefer Blondes " makes a study of the elements chlorine, bromine, and iodine either easier or more interesting. " Pep and Popularity," " Hydrogen : Nice Baby," and other phrases and analogies from the cinema screen or Hollywood, although light and humorous at times, are apt to grate on the minds of the kind of people, on this side of the Atlantic at least, who are most likely to put this book on their shelves. One chapter is headed " The Alchemists Were Right." It is a well written chapter on the subject of transmutation, unnecessarily spoiled, we think, by its title. For, in fact, the alchemists were not right. They were wrong, quite wrong. Modern science has shown that their views are not only dead but, as Disraeli might have added, damned. Nevertheless, these exuberances of style are not over numerous. In the main the exposition is " popular " in the good sense ; in parts it is very good ; it has the great merit of being trustworthy as to facts. The book affords a good popular introduction to inorganic chemistry and the classification of elements, to the nature and structure of the atom, and to radioactivity and such kindred subjects. The historical parts of the book are very well done. The illustrations are numerous and good.

The subject matter of *Engines*, like that of Sir William Bragg's book, was originally delivered as Christmas lectures to the young at the Royal Institution. Professor Andrade has evidently taken immense pains so to understand his subject that his readers too may understand it. The principles involved in all the main types of engines are set forth with great clarity and in excellent English. The author shows how, in some respects, all engines are alike, be they twelve-coupled locomotives or ice-machines, while, in others, they differ widely. The thirty-five plates which illustrate the book are well chosen and add immensely to the value of a really well-written and informed work which everybody can read with profit.

The Mechanism of Nature is a simple approach to modern views on matter and radiation. There are now quite a number of popular accounts of atomic structure and cognate problems, which aim at informing without terrifying the ordinary reader, but there is nothing so simply and gently put as this book. It is easy reading because the author has taken particular pains to do his job properly. There are no hearty similes followed by obscured paragraphs, no childish analogies printed side by side with undigested, difficult matter. The author never drops expository bricks or difficult mathematical formulae on his reader's toes. The opening chapter discusses what is physics. The succeeding chapters deal with heat and energy, with sound and vibration, with light and radiation, with electricity and magnetism, with the quantum theory and, finally, with the atom. The remarkable work on the disintegration of the atom, carried out at the Cavendish Laboratory last year, is shortly described. The original edition of this book, which received high praise on its appearance two years ago, was not illustrated. The present edition gains greatly from the seven plates which are now included. There is in addition, as frontispiece, a characteristic and previously unpublished photograph of Lord Rutherford of Nelson, to whom so much of what is best in modern nuclear physics is due.

The Nidification of Birds of the Indian Empire. By E. C. Stuart Baker. Vol. I.—Corvidae-Cinclidae. (Taylor & Francis. 30*s.*).

In *Discovery* for November, 1931, an account was given of the unique collection of eggs of the birds inhabiting the Indian Empire presented by Mr. E. C. Stuart Baker to the British Museum (Natural History). The author is now engaged in writing a complete account of all that is known of the breeding habits of Indian birds, under the above title. This work will occupy four volumes, the first of which was lately published, and deals with the first nine families of Passerine birds as described in the " Fauna of British India " series.

The nine families dealt with are the crow tribe, comprising crows, jays and pies, the titmice, the parrot-bills (also known as crow-tits), the nuthatches, the babblers and laughing thrushes, the bulbuls, the tree-creepers, the wrens, and the dippers. The number of species, sub-species and geographical races of these families which have been found in India, including Burma and Ceylon, amounts to 494, and it is a remarkable tribute to the thoroughness of the author's work that he is able to record something about the nesting habits of no less than 408, or approximately 82 per cent of the known varieties. Moreover, in the majority of cases a complete account is given of the breeding area, the elevation and nature of country where breeding takes place, followed by a careful description of the nest and eggs.

Hitherto the standard work on the subject has been Hume's " Nests and Eggs of Indian Birds," the second (and last) edition of which, by the late Mr. Oates, was published as long ago as 1889. The advance made in the knowledge of the subject during the past forty years is evidenced by the fact that Oates was then able to deal with only 48 per cent of the total; in many cases the information was meagre and frequently insufficiently authenticated. As stated by the author in his introduction, during the half century that he has been engaged in forming his collection, he has examined over 200,000 eggs either *in situ*, or obtained by his own trained collectors. In addition he has acquired the complete collections of some twenty-five other workers, as well as numerous individual clutches. With this wealth of material at his disposal, he is

able to produce a book which in authority and accuracy far surpasses anything that has previously been published.

Mr. Baker has, of course, followed the scientific nomenclature of the revised edition of the "Fauna of British India" of which he is the author. But in the trivial names he has broken new ground by eliminating entirely the surnames of persons, and in their place giving to each bird a name which has a definite meaning. Thus the bird formerly known as Harington's Babbler is now named the Burmese red-fronted babbler, "red fronted" being the specific character distinguishing the species from its nearest ally the red-headed babbler, while the word "Burmese" indicates the geographical race. The serial numbering of the birds is identical with that of the "Fauna of British India," a fact which will be of great convenience to field workers, and will enable them to number their specimens, whether of eggs or skins, to agree with either work.

The book is extremely well and clearly printed, and is embellished with eight beautiful plates, seven of these being from photographs and the other from a drawing by the author. Mr. Baker has once again achieved complete success, and the book is one which no worker in Indian ornithology can afford to be without, while all interested in wild life will find fascinating descriptions of nesting habits on every page.

Persia. By Sir Arnold T. Wilson. (Benn. 21*s*.).

Sir Arnold Wilson's new volume on Persia is a valuable addition to the "Modern World" series. His long official connexion with the Middle East has given him exceptional opportunities of studying Persia and her people, and he writes with real authority on the problems which confront the ancient country that is fast adopting Western methods while maintaining her individuality. Persian history, literature and art are so fully discussed in well-known modern works that Sir Arnold has been well advised to do no more than touch on them briefly and to give most of his space to the Persia of to-day which is relatively little understood. Under the new Shah, Riza Khan Pahlevi, who assumed the crown in 1925, Persia is being transformed into a modern State, based on a disciplined army and a strong centralized administration which has brought the most remote hill and desert tribes under its control. One of Persia's most valuable assets is the revenue from the Anglo-Persian Oil Company's concessions in Southern Persia. But other industries are growing, though hampered for the moment by the world-wide fall in prices. Railways and roads and a new port on the Gulf are being constructed.

Sir Arnold Wilson speaks highly of the Persian people, who are in the main Indo-Europeans like ourselves and who can hold their own with Western folk in intelligence and endurance. He stresses the fact that four-fifths of the population of 12,000,000 live on the land, and he is hopeful that industry will not be artificially stimulated so as to upset this distribution of the people. He attaches importance to the maintenance of the nomad herdsmen, who follow an immemorial tradition in driving their flocks and herds from summer to winter quarters and who are, in his view, a most valuable section of the nation. The Persians are rightly jealous of their independence, but unlike some other Asiatic nations they do not show a fanatical hatred of foreigners. The author discusses very forcibly the ill-conceived Anglo-Russian Convention of 1907 which seemed to foreshadow a partition of Persia and made the Persians suspicious of Great Britain. The Anglo-Persian agreement of 1919 was intended to assist Persia to recover from the chaos into which the war had thrown her, but it was rejected because it seemed to mean British tutelage. Under the new Shah Persia has made it clear that she will stand alone; the extra-territorial rights formerly enjoyed by foreigners have been abolished, and, except for the Belgian Customs Officers, no aliens are employed in the administration. The author believes that the Persians will succeed, if they are not in too great a hurry, in re-organizing their country, and the reasons for his faith are deserving of careful study. He did not foresee Persia's attempt to repudiate the Anglo-Persian concession, which has still thirty years to run. But his account of the nationalist movement sufficiently explains why that attempt to break a contract was made.

The Industrial Revolution in Scotland. By Henry Hamilton. (Clarendon Press. 15*s*.).

Dr. Hamilton's scholarly and interesting book on the Scottish Industrial Revolution is most welcome. It is the first serious attempt to deal with the subject, and it appears opportunely now that some Scottish people are advocating the repeal of the Union of 1707. For Dr. Hamilton shows in detail, as Professor Trevelyan has indicated more briefly in his *Ramillies*, that Scottish trade and industry and even her agriculture were insignificant before she was admitted into partnership with England and shared to the full the benefits of association with the richer country. The opening chapters on Scottish farming in the eighteenth century are impressive. Even the Lowlands were then as poverty-stricken as the West of Ireland was in mid-Victorian days, and the peasants tilling scattered patches of soil with primitive implements lived on the verge of famine. Intelligent landowners gradually changed all this, enclosing the land and redividing it into farms, introducing turnips for the winter feed of cattle, growing wheat instead of rye, and improving the breeds of cattle and sheep. By the end of the century Scottish agriculture was beginning to rival that of England and the country folk were better fed and better housed than they had ever been before. The Highland clearances over which so much sentiment has been expended removed half-starved peasants from hopelessly uneconomic conditions; many of them found wealth in Canada while others emigrated to the towns and prospered.

Scotland's first industry of note was the linen trade, to which the State through a Board of Trustees gave substantial help. When it passed from the domestic to the factory system, it was soon superseded by the cotton trade. Dr. Hamilton gives a valuable account of the rise and fall of the Scottish cotton manufacture, which depended largely on high quality rather than, as in Lancashire, on cheap staple lines and thus felt more acutely the competition of the Continent backed by tariffs. Incidentally, he shows that the sufferings of the hand-loom weavers were due to price-cutting which they were too unorganized to resist rather than to the introduction of the power-loom, which was exceptional before 1820 and could not produce fine cloths. The cotton famine caused by the American Civil War was a death-blow to the Scottish trade. Paisley continued to make its famous shawls till the 'seventies, but since then has concentrated on cotton thread, for which the sewing-machine—invented in 1846—created an immense demand.

Thenceforward coal, iron and steel, engineering and ship-building became the main Scottish industries, and of these the author gives a most instructive account. He brings out clearly the vital importance of the individual inventor. Until

Darby showed that iron could be smelted with coal, ironmasters had to go far and wide in search of wood to make into charcoal. It seems absurd, and yet is true, that in 1727 a Lancashire firm set up ironworks near Fort Augustus simply because of the woods there; all the plant, the ore and the workmen had to be imported at great expense, and after seven years the scheme was abandoned. When coal replaced charcoal, progress was easier. The Carron ironworks, founded by Garbett, Roebuck and Cadell in 1760, were the first of real importance. The firm soon specialized in gun-founding—producing the famous naval guns known as "carronades"—and steadily expanded. Cort's invention of puddling in 1784, Mushet's discovery in 1801 of the blackband ironstone and of the proper method of smelting it, and Neilson's invention in 1828 of the hot blast which saved two and a half tons of coal on every ton of pig-iron, were epoch-making events, which enabled the iron trade to expand at an amazing pace. The coal mines were rapidly developed to supply the needed fuel, and roads, canals and railways were made with the primary object of getting the coal to the furnaces. If there is any complaint to be made of Dr. Hamilton's plan, it is that he has not emphasized sufficiently the vital importance of Scottish coal to Scottish industry which without it could hardly have thriven. Engineering, as he says, was an entirely new trade when machines were invented, and its early imperfections delayed the general adoption of the steam engine and the machine for a generation or more. The Industrial Revolution even in England is usually antedated; in Scotland it was hardly in full swing till 1840 or even later.

Dr. Hamilton brings his excellent book to a close with a chapter on roads, canals and railways, and with a careful account of the Scottish banking system which enabled the scattered savings of many individuals to be concentrated for the financing of the new industries. Scotland owes an incalculable debt of gratitude to her bankers.

Eton College Natural History Society. Annual Report, 1931-32. (Price to non-members, 5*s*.).

The annual report of the Eton College Natural History Society records another busy year. Among the field observations carried out was a study of bird population in the neighbourhood of Black Potts. This area covers about six acres, and the vegetation consists of willow stumps which by the end of July had sprouted to a height of ten to twelve feet, with a thick undergrowth of goose-grass and high nettles. For purposes of observation the area was divided into three sections, each of which was surrounded by a fringe of tall willows. Ninety-three birds were ringed, including starlings, greenfinches, song thrushes, chaffinches, tree sparrows, sedge warblers, reed buntings, tree creepers, robins, swallows, moorhens, hedge sparrows, pied wagtails and one garden warbler. The report states that, compared with 1930, a considerable change has taken place. The osiers had not been cut and had therefore grown to twice their normal height. It is difficult to estimate how far this affected the conditions of bird life, owing to incomplete observation in 1930. A considerable increase in common white throats was observed, and a possible decrease in reed warblers. A pair of garden warblers nested in the Thames section of the area, a bird which had not been observed before: on the other hand, red-backed shrikes, which had been found breeding in previous years, appeared to be totally absent.

The Biological Laboratory has provided a home for a varied and interesting collection of animals. The secretary reports that "the old stagers are still alive and in good condition; they include two goldfish, now completing their sixth year in the laboratory, Bertha, a squirrel flying phalanger, and Bill, a maholi galago." The experiment was tried of keeping tropical fish in an aquarium heated by an electric bulb, apparently with satisfactory results. Many new specimens, collected in the neighbourhood of Eton, have been added to the collection of coleoptera. They have been identified by comparison with specimens in the British Museum (Natural History).

We congratulate the Society on another year of varied activity, and on the production of the report, which includes several handsome illustrations.

Jehol: City of Emperors. By SVEN HEDIN. Translated from the Swedish by E. G. NASH. (Kegan Paul. 18*s*.).

A hundred miles north of Peking, beyond the Great Wall that divides China from Manchuria, stands the city of Jehol, where the Manchu dynasty had their Summer Palace and where they built numerous temple-monasteries for their Lamaist subjects from Tibet and Mongolia. Mr. Sven Hedin's account of a visit to Jehol in 1930 has the charm of novelty and is illustrated with a large number of excellent photographs. He explains that he was commissioned by a Swedish-American in Chicago to obtain plans and photographs of the most beautiful Lamaist temple at Jehol, the Potala, so that replicas might be erected at Chicago and Stockholm. This Potala itself, copied from the temple at Lhasa, was built in the year 1767-71 by the Emperor Chien-Lung "as a sign of our encouragement and friendliness towards" the vassals over the border of China. Inside a vast rectangular stone building, which is a mere shell, the richly decorated temple with gilded roof is hidden from the world and, apparently, is now utterly neglected, save for the few decrepit monks and ill paid soldiers that haunt the place. Yet as a fine example of Chinese art devoted to the service of the Tibetan religion it clearly deserves a better fate. Mr. Hedin describes the neighbouring temples briefly and has something to say of the perils of his motor trip along what was once the well kept "Emperor's road" but is now a perilous track which it is no one's business to maintain. Much of the volume is devoted to somewhat fanciful accounts of the return of the Kalmucks from Southern Russia to Mongolia in 1771 and of the visit of the Tashi Lama to Jehol and Peking in 1780, when he died. There are chapters, too, on the court of Kang-hsi and Chien-lung, and at the end the well-known story of the late Dowager Empress's rise to power at the death of the Emperor Hsien-feng, the father of her son, the Emperor Tung-chih. One could have wished for a good deal more about Jehol and a good deal less about the Manchu Emperors, but Mr. Hedin's book is deserving of attention.

The Conquest of the South Pole. Antarctic Exploration, 1906-1931. By J. GORDON HAYES. (Thornton Butterworth. 18*s*.).

So many expeditions have done good work in the Antarctic during the past quarter of a century that only the geographical expert can profess to have kept pace with them. Mr. Gordon Hayes has deserved well of the ordinary reader in preparing a concise and clearly written account of what has been achieved, with a number of useful charts and many good photographs. He distinguishes between the "Homeric" or pre-war period of

Shackleton, Scott, Charcot, Amundsen and Mawson, and the "Mechanic" or post-war period in which Mawson again, Wilkins, Byrd, Rijssen-Larsen and others have had aeroplanes as well as better equipment to aid them in their explorations. Three-fourths of the book is given to those remarkable earlier explorers who by their courage and endurance triumphed over the dangers of the Ross Barrier and two of whom reached the South Pole on its lofty and barren plateau. Shackleton did not reach the Pole, but his long and toilsome sledge journey across the Barrier to the plateau was, in the author's view, perhaps the most remarkable feat in South Polar history. And Sir Edgeworth David and Sir Douglas Mawson were members of Shackleton's party when they attained the South Magnetic Pole in 1909. Scott's famous and fatal journey is well described, and care is taken to emphasize the high value of the discoveries made by his party in the Ross Quadrant. Mawson's pre-war voyages in the "Aurora" traced the coast-line of the Antarctic continent from the Ross Sea as far as Queen Mary Land. Shackleton's expedition in the "Endurance" to the Weddell Sea just before the war would have ended fatally for them all but for the leader's astonishing boat voyage, when his ship was wrecked, to South Georgia, where he found help.

The post-war section of the book is more novel. Mr. Hayes has made a serious effort to explain what the recent explorers, especially Byrd and Mawson, have achieved. Admiral Byrd, with his large and imposing American expedition, made great use of aeroplanes not merely to fly over the South Pole but also to explore the unknown region beyond the Ross Quadrant, incidentally showing that Amundsen had been deceived by a haze when he thought he saw the end of the Barrier and land beyond. But appearances are often deceptive in the South Polar regions, on land as well as at sea. Mawson, in his epoch-making voyages of 1929-31, traced the coast of the Antarctic continent from the Ross Sea to Enderby Land, for 2,500 miles in all, and incidentally proved that several reported lands did not exist. On the other hand, in definitely sighting Enderby Land he confirmed the report made a century before by the stout whaler Captain Biscoe, in one of the Enderbys' ships. No one in the interval had sighted that lofty coast which is now technically a British possession. Aeroplanes have made it easier to survey the Antarctic, but the danger and monotony of exploration in that desolate region are not lessened, and the stormy seas that surround it still have their perils. The conquest of the Antarctic is only begun, and there is still abundant scope for the adventurous scientist in that terribly impressive region.

Clothes Moths and House Moths. Their History, Habits and Control. By MAJOR E. E. AUSTIN and A. W. MCKENNY. (British Museum: Natural History. 6*d*.).

The clothes and house moths are probably the most troublesome of all our domestic insect pests, and the total amount of damage they do must attain an immense figure, for there can hardly be a house in the country free from the attacks of at least one of the six species. The latest pamphlet published by the British Museum in their very useful economic series deals with these pests, and in spite of its modest appearance and price, has attracted wide attention in the daily Press. Although its distinguished authors do not claim that it is much more than a compilation of recent research, by Titschack, Nagel, and others in Germany, and in the United States by Back, Cotton and Benedict, it is of great practical value. It should be understood that the actual damage is done only by the larva and in secret, so that it is often not revealed until a later date, for the adults are incapable of feeding, but can only reproduce their kind. A remarkable fact about the case-bearing species is that it is addicted to the most improbable and apparently impossible foodstuffs, "among which have been recorded *Aconitum* root, Cayenne pepper, horseradish, *Strophanthus* (used as an arrow poison in East Africa), Indian hemp, cherry-leaf laurel, black mustard seed, ginger, orris root, laurel leaves, poppy capsules, linseed, almonds, saffron, and a monkey's skin used as a bag for bitter aloes." The brown house moth was not recognized until described by Stainton in 1849, since when it has spread extensively and is now commonly seen running on walls. It appears to have changed its habits in recent years and started attacking animal substances early this century. Owing to its versatility it threatens to become the greatest pest of all. It is particularly dangerous in museums. In the underground rooms of the Bodleian Library, out of 1,600 books no less than 40 per cent were infested, of which 15 per cent seriously. Only the leather bindings were attacked, the cloth neglected. This faculty for changing habits is a feature of all, for their domestication must be a recent phenomenon compared with the age of the species. Durrant has noted that the white-tipped is not normally an indoor species, owing to its resemblance to a bird's dropping. Probably all were originally scavengers.

Like other domestic animals and pests, they seem all unknown in the wild state and their original home is uncertain. Meyrick suggests that the Common Clothes Moth is of African origin, and the Large Pale, it is suggested, was imported from South America. From association with mankind, they are now almost cosmopolitan. A remarkable feature of them is their power of going dormant in the larval stage for a prolonged period. The longest life recorded for a larva is four years.

A History of the Georgian People. By W. E. D. ALLEN. (Kegan Paul. 31*s*. 6*d*.).

As Sir Denison Ross says in his introduction, Mr. Allen's history of Georgia is the first to appear in English. What is more, it is most ably written and extremely interesting. Mr. Allen begins with the prehistoric Armenoids of the hills and valleys between the Black Sea and the Caspian, passes on to the fertile and wealthy Colchis (the coast land) and Iberia (the central plain) that the Greeks and Romans knew, and then deals at length with the complicated and, to English readers, virtually unknown history of Georgia through the Middle Ages, harassed continually by Turks, Mongols, Turks again, Persians and Russians, till at last the Russians won the game. In the twelfth century, thanks to the Crusades which diverted the Moslem armies to Syria, Georgia had a brief spell of peace. But for the most part her history is a record of foreign invasion and domestic dissension. It seems a marvel that the Georgians were not long since wiped out, like the Armenians. But Mr. Allen observes first that Georgia is a pleasant and rich country, unlike the Armenian mountains, and secondly that the Georgians are characterized by an "aesthetic irresponsibility" which is "the secret both of their charm as a nation and of their survival as a strongly individualistic national unit."

The chapter on the art of mediaeval Georgia is particularly to be commended. Mr. Allen delights in the enamels and gives some illustrations of them, which justify his praise. The illustrations include photographs of the country and reproductions of old prints and drawings.

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